Manual

BASIC SCIENCE EDUCATION SERIES

JUNIOR HIGH

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Revised

Teaching Manual

to accompany

THE BASIC SCIENCE EDUCATION SERIES

by

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LABORATORY SCHOOL, UNIVERSITY OF CHICAGO

Junior High

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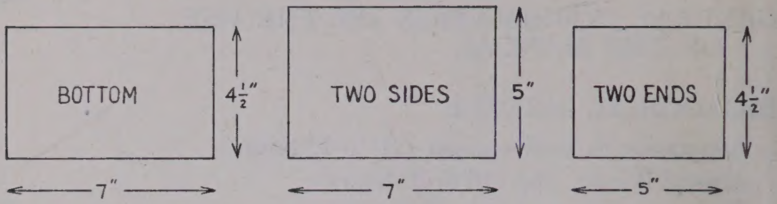
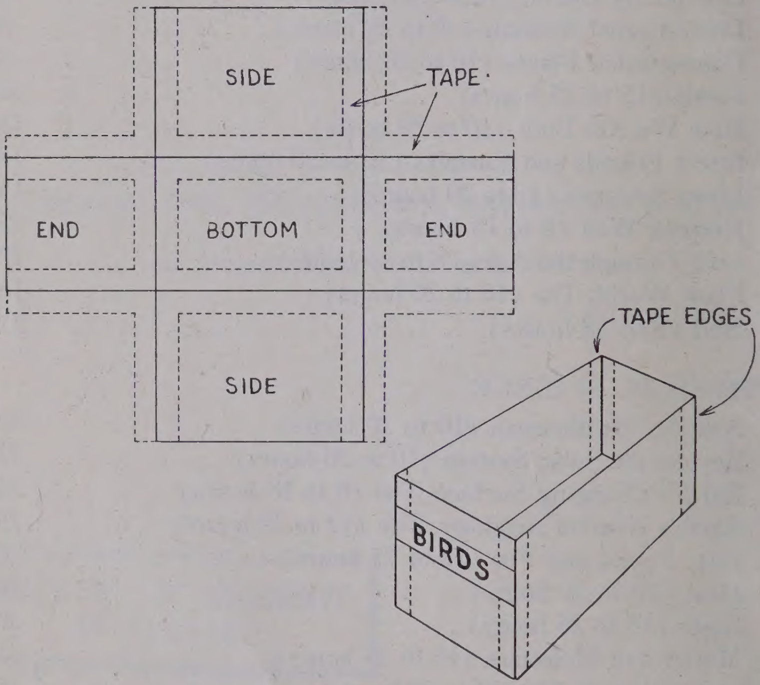
PATTERN FOR UNITEXT CONTAINER





First, cut five pieces of cardboard the sizes as shown at top of page.

Second, tape the cardboard as in Fig. 1.

Third, complete box by taping sides and ends together as in Fig. 2. Reinforce inside corners of box with extra tape.

This container when completed will hold a set of Thirty Unitexts. Print title on end of box. For larger sets of Unitexts cut ends and bottom of box wider. For smaller sets of Unitexts cut ends and bottom of box narrower.

GENERAL INFORMATION ON THE USE OF THIS MANUAL

1. These science topics, or units, may be studied in any order dictated by the local course of study or curriculum plan and provided for by the purchase of unitexts for the pupils. The unitexts are independent of one another. The authors have not taken for granted in the preparation of any one unitext that any other one will have been studied previously.

2. The importance of good reading material in the teaching of science is unquestioned. Good text material cannot make its greatest possible contribution toward the recognized goals of science-teaching, however, unless good teaching techniques are employed. The teaching outlines here provided are designed to help teachers handle the unitext material in such a way as to make it contribute most fully toward the desired goals.

3. The amount of time devoted to a unit or to any division of a unit will depend on the local importance of the topic and its place in the curriculum that is being followed. Suggestions based on wide experience are given as to the maximum and minimum number of hours that may profitably be devoted to each unit. Less than the minimum would mean superficial work in most cases; more than the maximum would be likely to mean a waste of time, unless exceptional interest has been aroused and many activities in addition to those suggested in the outline are being carried on.

4. The divisions of the teaching outline for each unit correspond in the main to the divisions of the unitext itself. They are in no sense meant to be divisions of the unit into lessons. Some of the divisions can be covered in one class period or even less; others may require several class periods. In some cases two or more divisions of the unitext have been grouped together in the teaching outline because they are so closely tied together that one approach serves to introduce them all.

5. Under each division the sections entitled "Core Ideas" and "Possible Approach" are addressed to the teacher. It is not expected that the teacher will always follow the approaches suggested. Often questions raised by the class or illustrative materials brought in by pupils will serve as more appropriate approaches. Those

suggested should prove helpful unless class initiative alone keeps the unit moving toward the desired ends. In many cases the Approach calls for the reading of some part of the unitext material. It is expected that, after the topic has been introduced, the reading of the remainder of the text material will be motivated by problems and that activities having a direct bearing on the topic will be carried on. Some of the problems will normally be raised by the pupils themselves. The teacher will find the Study Problems and Exercises a source of additional problems that will serve to motivate the reading of the text.

6. In each division the sections entitled "Activities" and "Study Problems and Exercises" are addressed to the pupils and are to be supplied to them by the teacher. Parenthetically in those sections, however, helps are offered to the teacher concerning correct answers or results to be expected. It is not anticipated that in the majority of cases all the activities suggested will be pursued. Some of those suggested, for example, are seasonal in character and can be carried on only if the unit is being handled at a certain season. Neither is it expected that all the activities selected will be carried on by the pupils themselves. The teacher should first select the activities which seem appropriate for the class and which can be carried on with the materials available. The teacher should then decide whether an activity selected can best be carried on as an individual enterprise or as a pupil- or teacher-demonstration.

The Activities and the Study Problems and Exercises may be presented to the pupils orally, in writing on the board, or in hectographed or mimeographed form. The teacher is free to make as many copies of the Activities and Study Problems and Exercises as he wishes.

In some cases the teacher will doubtless wish to provide those exercises which are to be done in writing a few at a time as the portion of the unit with which they deal is being discussed. In other cases the teacher may wish to do all the direct teaching—oral discussion and activities other than written exercises—first and at its completion give the class at one time all the exercises to be done in writing. Each individual can then work through the entire set of exercises at his own speed, and the faster workers will have time for pursuing individual interests.

In the suggestions for activities moving pictures are not mentioned. It is expected, however, that the teacher will use moving pictures whenever it is possible to obtain pictures that will contribute toward the development of the core ideas of the unit.

7. In connection with the individual units no suggestions in most cases are made for concluding exercises. The concluding exercises of a unit may well take one or more of these three forms:

a) A test covering the whole unit and emphasizing generalizations and applications of principles as well as facts.

b) A summary, worked out by the class as a whole or by each individual, of the main ideas of the unit.

c) The giving of an assembly exercise based on the unit. The giving of such an exercise makes necessary a consideration of the unit as a whole. Moreover, retelling the content in an audience situation does much to fix it in the minds of the tellers.

8. At the conclusion of each unit outline a list is given of all the materials and equipment called for in the suggestions for approaches and activities. Obviously, if not all the suggested activities are carried on, some of the items on the list will not be needed. In the list the teacher is told, by means of a key, where each item not in very common use may be obtained. Some of the items can best be had from laboratory-supply houses. A list of a few such houses is given on page 405.

In many cases a substitute can be found for a piece of equipment called for in the directions given. In such cases possible substitutes are indicated in parentheses in the directions.

9. At the conclusion of the teaching outlines a list of reference books for the teacher is given. The list is not extensive, because it is felt that a list of two or three good source books in connection with each unit will be more helpful than a more extensive list. At the beginning of the list general reference books are listed that will be found helpful in connection with many different units.

10. See page 4 of this manual for a pattern to make containers for the Unitext Sets to be used in class.

ADAPTATION TO ENVIRONMENT

(Note general information page 5)

I. THE MENHADEN; II. THE BARN SWALLOW; III. THE ARCTIC FOX; IV. THE WATER HYACINTH; V. THE TREE CACTUS; VI. HABITATS (pages 3-17)

Core Ideas

Different plants and animals are fitted for living in different habitats.

There are habitats within habitats.

Habitats differ from one another in many ways: amount of moisture, temperature, amount of light, pressure, amount of oxygen available, amount of food present, and plant and animal populations.

Possible Approach

Show two pictures based on the pictures on pages 2 and 6 of the unitext, but with the habitats interchanged, i.e., with the barn swallow under water and the menhaden in the air. Raise the question of why these pictures represent impossibilities—of why the menhaden can live only in water and the barn swallow only in air. Check by reading pages 3-6. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activities

1. Collect some plankton and examine it under the microscope.
2. Use clay to illustrate one way in which the menhaden and barn swallow are alike.
3. Examine a feather with a microscope.

4. Grow a water hyacinth plant in an aquarium. Note especially the balloons.

5. Plant a small cactus garden in a terrarium.

6. Follow suggestion No. 1 on page 36 of the unitext.

7. Follow suggestion No. 2 on page 36 of the unitext.

8. Follow suggestion No. 3 on page 36 of the unitext.

9. Follow suggestion No. 4 on page 36 of the unitext.

10. Follow suggestion No. 8 on page 36 of the unitext.

11. Follow suggestion No. 9 on page 36 of the unitext.

12. Follow suggestion No. 11 on page 36 of the unitext.

13. Follow suggestion No. 12 on page 36 of the unitext.

14. Collect and mount pictures to show groups of living things which live together in certain habitats.

Study Problems and Exercises

1. Mark each of the following sentences true or false:

X (1) Menhaden make up a large part of the plankton on which so many animals of the sea feed.

C (2) Plankton is made up of both plants and animals.

X (3) The reason menhaden are not often eaten is that they are very scarce.

X (4) Menhaden live in the deep sea.

X (5) From their looks no one would guess that the menhaden is a kind of fish.

2. Fill in the blank spaces with words which complete the ideas correctly:

Menhaden, like all fishes, breathe by means of (*gills*). The thin fringes of membrane which make up the gills contain many tiny (*blood vessels*). As the water taken in by the mouth passes over the gills, (*oxygen*) from the water goes into the fish's blood. The (*gill rakers*) strain out the plankton from the water.

3. Draw a line under each of the following statements which tells of a way in which the menhaden is fitted for living where it does:

1) Menhaden have gills.
2) Menhaden live in the sea.
3) Menhaden have a great deal of fat in their bodies.

4) Menhaden have swim bladders.
5) Menhaden have fins.
6) Menhaden are not commonly caught for food for man.
7) Menhaden are streamlined.
8) Menhaden scales overlap like shingles on a roof and are fastened at the front.
9) Menhaden are lighter in color below than above.
10) Menhaden migrate to warmer waters in the fall.

4. What is the advantage to a fish of having a short, deep body like that of the angelfish? (*P. 4, ¶ 4*)

5. Is the menhaden handicapped because it cannot stop so quickly? (*No.*) Why or why not? (*P. 4, ¶ 4*)

6. Would you be likely to see a barn swallow scratching for worms in a garden? (*No.*) Why or why not? (*P. 5, ¶ 2*)

7. Draw a line under each of the following statements which tells of a way in which the barn swallow is fitted for living where it does.

1) A barn swallow cannot float.
2) A barn swallow has a light body.
3) A barn swallow's bones are hollow.
4) A barn swallow has strong wings.
5) Birds are warm blooded.
6) A barn swallow has a wide mouth and a short bill.
7) Barn swallows escape the cold of the north by migrating.

8. Place a *C* in front of each of the following sentences which helps explain why feathers make a good wing and body covering for birds:

(1) Feathers allow water to pass freely through to the bird's skin to help keep it cool and moist.
C (2) Feathers shed water because they are oily and because of the way the parts of the feathers are fitted together.
C (3) Feathers are light, tough, and strong.
C (4) Birds are warm blooded, and feathers are a help in keeping their bodies warm.
(5) Birds are cold blooded, and feathers are a help in keeping their bodies cold.

9. How is the arctic fox fitted for keeping warm? (*P. 7, ¶ 5*)

10. List three ways in which the arctic fox is fitted to be a meat eater. (*P. 8, ¶¶ 1 and 3*)

11. How is the arctic fox protected from its enemies? (*P. 8, ¶ 3*)

12. If you live in the north, what are you likely to think about the water hyacinth? (*That it is a pretty plant to buy.*) If you live in the south, what are you likely to think about the water hyacinth? (*That it is a nuisance to be destroyed.*) Why this difference of opinion? (*P. 9, ¶ 2*)

13. In what special way is the water hyacinth well fitted for its life in the water? (*P. 9, ¶ 3*)

14. Tell four important ways in which the tree cactus is fitted for living where it does. (*P. 10, ¶¶ 3-5, p. 11, ¶ 1*)

15. Which of the two plants, the tree cactus and the water hyacinth, lives under conditions more nearly like those under which its earliest ancestors lived? (*Water hyacinth.*) Quote a sentence which backs up your answer. (*P. 11, ¶ 3*)

16. There are many giraffes in zoos. Would it be correct to say that the giraffe's habitat is the zoo? Why or why not? (*P. 12, ¶ 1*)

17. What is the picture on the inside covers intended to show? (*P. 12, ¶ 4*)

18. Name the habitat represented in each of the following pictures: P. 2 (*ocean*), p. 6 (*air*), p. 8 (*arctic region*), p. 9 (*warm stream or canal*), p. 11 (*desert*), p. 12 (*mountains*), p. 13 (*prairie*), *p.* 14 (*forest*), p. 15 (*clear, swift-flowing stream*), p. 16 (*seashore*), p. 17 (*sand dune*).

19. Tell six ways in which habitats may differ from one another. (*Pp. 13-15: moistuге, temperature, light, pressure, oxygen, food available.*)

20. Mark each of the following sentences true or false:

C (1) Land habitats differ in temperature much more than water habitats do.
X (2) Only land habitats differ in the amount of light.
C (3) Both air and water exert pressure.
X (4) The amount of air is important only because of the pressure it exerts.
C (5) Green plants manufacture their own food.

C (6) In manufacturing their food green plants use raw materials from air, water, and soil.

C (7) Deep-sea fishes die when they are pulled up to the surface because of the sudden decrease in pressure.

C (8) Cool water can hold more oxygen than warm water.

X (9) The menhaden could get along very well in the habitat of the brook trout.

C (10) In considering how well a plant or animal is fitted for living where it does, one should consider the other living things in the habitat.

21. Rewrite the following sentence, substituting for the words underlined another group of words which mean the same:

The brook trout is well fitted for living where it does (*adapted to its environment*).

VII. GETTING WATER (pages 18-19)

Core Ideas

Some plants and animals require less water than others.

Some plants and animals have special devices for storing water.

Some plants and animals have special devices to prevent rapid loss of water by evaporation.

Many plants take in water through their roots, while many animals drink water, but various plants and animals have other ways of getting the water they need.

Possible Approach

Assemble a collection of living plants and animals. Discuss the ways in which these plants and animals meet the problem of getting enough water. Find out from the text about other ways of meeting the problem.

Activities

1. Collect and mount pictures to illustrate different ways in which living things get the water they need.

2. Plan an experiment to find out whether some potted plant, a geranium, for example, could take in the water it needs through its leaves rather than through its roots.

Study Problems and Exercises

1. In what kind of habitat do all three of the animals pictured on page 18 live? (*Desert.*)

2. How do the following living things solve the problem of water scarcity?

The three animals pictured on page 18. (*By being small.*)
The camel. (*By storing water in its body.*)
Many desert plants. (*By being leafless, by having wax-covered leaves and stems, by storing water in leaves or stems.*)
The epiphyte pictured on page 19. (*By having stiff leaves which form a "rain barrel."*)
The mistletoe. (*By sending its roots down into a tree and "stealing" it.*)

VIII. GETTING OXYGEN (pages 20-22)

Core Ideas

Among animals common devices for getting the oxygen needed are lungs, gills, and spiracles.

Getting oxygen constitutes a special problem for air-breathing animals that live in water and for underwater breathers that have to be out of water at times.

As a rule, land plants take in the oxygen they need through pores called stomata, while plants that live under water simply take in the oxygen they need through their outer covering.

Some plants and animals have special adaptations for getting oxygen.

Possible Approach

Discuss the ways in which the various plants and animals in the science room meet the problem of getting oxygen. Find out from the text about other ways of meeting this problem.

Activities

1. Make a chart with three headings: "Lungs," "Gills," and "Other Means of Getting Oxygen." Collect pictures of various animals and mount them on the chart to show how they get oxygen.

2. Watch a goldfish breathe.

3. A mudpuppy gets oxygen throughout its life by means of external gills. Examine a mudpuppy or a picture of one.

4. Find pictures of insects that show spiracles.

5. With a microscope examine a bit of the skin of a leaf. Look for stomata.

Study Problems and Exercises

1. Name one animal or group of animals that gets oxygen in each of the following ways:
From air by means of lungs (*P. 20, ¶ 1*)
From water by means of gills (*P. 20, ¶¶ 1, 3, and 4*)
From air through their moist skin (*P. 20, ¶ 2*)
From air by means of spiracles (*P. 20, ¶ 4*)
From air by means of book lungs (*P. 20, ¶ 5*)

2. What group of vertebrates normally get oxygen in two different ways at two different stages in their life-histories? (*Amphibians.*)

3. Each of the following animals lives in the water but must take oxygen from the air. How does each solve the problem?
Water spider (*P. 21, ¶ 2*)
Dolphin (*P. 21, ¶ 3*)
Young mosquitoes (*P. 21, ¶ 5*)

4. What special adaptation for getting oxygen do water lilies have? (*P. 22, ¶ 4*)

5. Mark each of the following sentences true or false:
X (1) Plants differ from people in that they do not have to have oxygen.
C (2) Oxygen is a waste product given off when sugar is made in green plants.
C (3) Light is necessary for sugar-making in green plants.
C (4) Carbon dioxide is used by plants in sugar-making.
C (5) Dependent plants—plants that cannot make their own food—must take in oxygen all the time.

IX. GETTING FOOD (pages 23-25)

Core Ideas

Some animals hunt for their food, while others wait for food to come to them.

Different animals show widely different adaptations for food-getting.

Green plants make food for themselves, but some have additional ways of getting food.

Plants that are not green cannot, as a rule, make their own food and must have ways of taking in the food they need.

Possible Approach

Discuss the ways in which the various plants and animals in the science room meet the problem of getting food. Find out from the text about other adaptations for food-getting.

Activities

1. Keep and feed as many different kinds of animals as you can in the schoolroom.
2. Collect and mount pictures of animals engaged in getting food.
3. Look up additional material about how plants make their own food. PLANT FACTORIES, another unitext, will be helpful.
4. Get and keep in the classroom some insect-catching plants —pitcher plant, Venus's fly trap, etc.
5. With clay, model birds' beaks to show adaptations for food-getting. BIRDS, another unitext will be helpful.

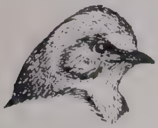
Study Problems and Exercises

1. The sea anemone and the arctic fox are very different in their ways of getting food. What is the most outstanding difference? (*Arctic fox hunts for its food; sea anemone waits for food to come to it.*)

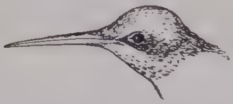
2. Below is a list of adaptations for food-getting. After each, name an animal that possesses the adaptation.

Poison darts at the ends of threads (*Sea anemone*)
Feathery legs that "kick" tiny animals into its mouth (*Barnacle*)
Tube feet with suckers at the ends (*Starfish*)
A strong sharp bill useful in digging holes in wood to get insects (*Woodpecker*)
A "fish basket" for a lower bill (*Pelican*)
A long neck useful in eating leaves from trees (*Giraffe*)
A long snout and a very long, sticky tongue useful in catching ants (*Great anteater*)

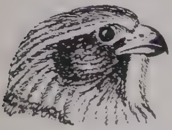
3. Here are some pictures of bird bills and a list of foods. Write under each bill the food in the list which you think it is best adapted for getting.



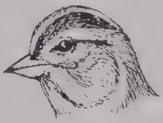
(*Mosquitoes in flight*)



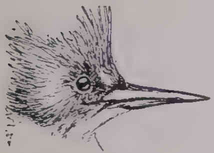
(*Flower nectar*)



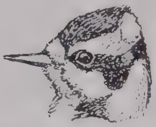
(*Field mice*)



(*Seeds*)



(*Fish*)



(*Insects from tree trunks*)

Flower nectar

Mosquitoes

Field mice

Insects from tree trunks

Seeds

Fish

4. A special adaptation for food-getting is represented in each picture on page 25. What is it? Top (*P. 25, ¶ 2*); middle (*P. 24, ¶ 3*); bottom (*P. 24, ¶ 5*).

5. Fill in the blanks in these sentences so that the statements are accurate:

(*California pitcher*) plants by trapping insects get extra (*nitrogen*) for making food. The leaves of these plants are shaped somewhat like (*pitchers*). Bright-colored banners hanging down from the mouths of the pitchers serve to attract (*insects*). Once inside the pitcher the insects cannot easily escape, for they keep flying toward the (*window-like*) places in the leaves instead of toward the real opening. The tired insects then fall into the water at the bottom and are (*digested*) by the leaf.

6. Name a plant that is adapted for getting its food from dead plant material. (*Parasol mushroom*)

X. GETTING WARMTH (pages 26-27)

Core Ideas

There are definite temperature limits beyond which protoplasm cannot go and remain alive.

Plants and cold-blooded animals depend for warmth on their surroundings.

Possible Approach

Call attention to the fish in an aquarium. Ask how to find out the temperature of the fish. Refer the class to the text for suggestions. (Since fish are cold-blooded animals, their approximate temperature can be found by taking the temperature of the water around them.)

Activities

1. Look at cells through a microscope to see the protoplasm in them. *Elodea* cells show it well.
2. Collect pictures and make a chart showing examples of cold-blooded animals and of warm-blooded animals.
3. Plan and carry out an experiment to show that fur is a poor conductor of heat.

Study Problems and Exercises

1. Justify this statement:

"The basic stuff of life is protoplasm." (*All living things are made of cells, the living material of which is protoplasm.*)

2. Why are there upper and lower limits to the temperatures which living things can stand? (*P. 26, ¶ 2*)

3. In what two ways can animals get the warmth they must have? (*P. 26, ¶ 4*)

4. In what way do cold-blooded animals get warmth? (*From their surroundings.*)

5. In what ways do warm-blooded animals get their warmth? (*From their surroundings and from food.*)

6. How do warm-blooded animals get warmth from food? (*P. 27, ¶ 1*)

7. From the standpoint of body temperature, what useful purpose do fur, feathers, and fat serve? (*P. 27, ¶¶ 2-3*)

8. Food is also oxidized in the bodies of cold-blooded animals and in plants. Why do they not become so warm as warm-blooded animals? (*P. 27, ¶ 4*)

XI. GETTING LIGHT (pages 28-29)

Core Ideas

Green plants must have light in order to manufacture food for themselves.

Different green plants have different adaptations for getting light.

Many animals depend on light to help them find food.

Some animals are especially adapted for living in sunless habitats.

Possible Approach

Discuss the living plants and animals in the science room from the standpoint of whether they show any special adaptations for getting the amount of light needed. Find out from the text about other adaptations for getting the right amount of light.

Activities

1. Collect and mount pictures of animals which furnish their own light.
2. Follow suggestion No. 7 on page 36 of the unitext.

Study Problems and Exercises

1. Make sketches to show three ways in which plants get for their leaves the light needed for food-making.
2. Why is each of the following pictures included in the book? Page 28 (*P. 29, ¶ 5*); page 29, top (*P. 29, ¶ 3*); page 29, bottom (*P. 29, ¶ 4*).
3. Would the picture on page 28 be more realistic if some seaweeds were included in it? Back up your answer by quoting a sentence from the book. (*No. P. 29, ¶ 5, first sentence.*)

XII. WAYS OF MOVING (pages 30-32)

Core Ideas

Most plants stay in one place all their lives, but they show various adaptations for getting their spores or seeds scattered.

Seed plants have many different devices for insuring the scattering of their pollen by wind or insects.

Animals have a great many different ways of moving about, some suited for one environment, some for another.

Earth history furnishes instances to show that, as environments change through the ages, animals may change so that they are better fitted for moving about in the changed environments.

Possible Approach

Discuss the plants and animals in the science room from the standpoint of special adaptations for moving from place to place. Find out from the text about additional ways in which living things move from one place to another.

Activities

1. Collect pictures of animals in motion.
2. Find out by watching snails, fish, clams, and other animals in an aquarium as much as you can about how they move.
3. Follow suggestion No. 5 on page 36 of the unitext.
4. Follow suggestion No. 6 on page 36 of the unitext.

Study Problems and Exercises

1. What three plant parts do the most traveling? (*P. 30, ¶ 1*)
2. How is each of the following adapted for seed dispersal? What is the agent which aids it?

	Milkweed	Cocklebur	Elm seeds	Lotus	Apple
Adaptation:	*(Down)*	*(Stickers)*	*(Wings)*	*("Boats")*	*(Bright-colored edible fruit)*
Agent:	*(Wind)*	*(Furry animals)*	*(Wind)*	*(Water)*	*(Animals)*

3. Following is a list of ways of locomotion. Opposite each, name an adaptation which makes this type of locomotion possible.

Flying (*Wings*) (*P. 32, ¶ 1*)
Swimming (*P. 31, ¶ 3*)
Jumping (*P. 32, ¶ 3*)
Walking on ocean floor (*P. 31, ¶ 4*)
Swinging in trees (*P. 32, ¶ 3*)

4. List seven types of locomotion illustrated in the picture at the bottom of pages 32 and 33. (*Flying, swimming, crawling, walking, running, leaping, hopping, scampering.*)

5. How did horses in the course of millions of years become adapted to a changed environment? (*P. 32, ¶ 5*)

XIII. MEANS OF PROTECTION (pages 33-35)

Core Ideas

Plants and animals have various ways of protecting themselves from their enemies.

They also have various ways of protecting themselves from adverse temperature conditions.

Possible Approach

Discuss the plants and animals in the science room from the standpoint of their means of protection from their enemies and from cold weather. Find out from the text about other means of protection plants and animals may have.

Activities

1. Collect and mount pictures of animals which have weapons with which they protect themselves.
2. Collect and mount pictures to show ways in which plants protect themselves.
3. Make a collection of plants or plant parts to illustrate ways in which plants protect themselves.
4. Follow suggestion No. 10 on page 36 of the unitext.
5. Make a diorama to illustrate protective coloration.

Study Problems and Exercises

1. Below are five ways in which animals protect themselves from their enemies. Give an example of each.

Speed of moving (*P. 33, ¶ 1*)
Protective resemblance (*P. 33, ¶¶ 2-3*)
Protective armor (*P. 33, ¶ 4*)
Good weapons (*P. 33, ¶ 5*)
Protective habits (*P. 34, ¶ 1*)

2. Name three means of protection found among both plants and animals and give both a plant and an animal example of each.

Adaptation	Plant Example	Animal Example
(Spines)	*(Cactus)*	*(Porcupine)*
(Bad odor)	*(Skunk cabbage)*	*(Skunk)*
(Thick covering)	*(Black walnut)*	*(Cecropia caterpillar)*
(Food-storing)	*(Beets, carrots)*	*(Chipmunk)*

3. In what special way do each of the following living things protect themselves from winter conditions?

Cecropia caterpillars (*Make a cocoon.*)
Chipmunks (*Store food.*)
Broad-leaved trees (*Shed leaves.*)
Toads and frogs (*Hibernate.*)
Woodchucks (*Hibernate.*)
Canada geese (*Migrate.*)

Materials and Equipment

(See page 405)

Microscope 4
Several terrariums 4
Several aquariums 4
Chemical thermometer 4
Plants and animals for different habitat terrariums 4
Plants and animals for fresh-water aquarium (including goldfish, snails, *Elodea,* and water hyacinth) 4
Plants and animals for marine aquarium 4
Hamsters or other small mammals 4
Mudpuppy, or picture of one 4
Insect-trapping plants: pitcher plant, Venus's fly trap 4
Potted plants of one or more kinds
Seeds of various types
Feathers
Fur
Modeling clay 5
Materials for protective-coloration dioramas
PLANT FACTORIES
BIRDS

THE ANIMAL WORLD

(Note general information page 5)

I. INTRODUCTION (pages 3-4)

Core Ideas

Plants and animals are alike in many ways.

The higher plants differ from the higher animals in enough ways to make it easy to tell the two groups apart, but some simple living things are on the borderline between the plant and animal kingdoms.

Possible Approach

Show a collection of pictures or specimens of a number of plants and animals, all easily identifiable as one or the other. Ask the class to divide them into the two groups. Point out that although some are plants and some animals all the living things shown are alike in certain ways. List ways as the class suggests them in which they are alike. Check the list with the one given on page 3 of the unitext. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activities

1. Place an *Elodea* leaf under the microscope. Look for the chloroplasts containing the green pigment chlorophyll. Also notice the cells of which the leaf is made.

2. It is possible to buy permanent slides showing cells from various many-celled animals. Examine some such slides if possible.

3. Follow suggestion No. 7 on page 36 of the unitext.

4. When you visit a conservatory or a florist, ask whether they have *Mimosa,* the sensitive plant. Seeds and seedlings of

this plant can also be bought from seed stores or biological supply houses. The leaves of this plant will fold up and the stem will droop when touched.

5. Place an actively growing geranium plant so that it receives light from only one direction. Watch to see whether it turns toward the light in a few hours.

Study Problems and Exercises

1. List eight ways in which plants and animals are alike. (*Growth; movement; reproduction; organization into different parts for different purposes; chemical changes; ability to change when conditions change; need for food, water, oxygen; protoplasm.*)

2. In the list below place an *A* in front of each characteristic which fits most animals and a *P* in front of each characteristic which fits most plants:

(*P*) They have green pigment which enables them to make their own food.
(*P*) They generally stay in one place all their lives.
(*P*) Their cells have walls of cellulose.
(*A*) They move easily from place to place.
(*A*) They take in food already made.
(*A*) They have no cellulose cell walls.
(*A*) They respond to stimuli readily.
(*P*) They respond to stimuli slowly.

3. What is unusual about the living things pictured on page 4? (*P. 4, ¶ 6*)

II. Classifying Animals (pages 5-7)

Core Ideas

Scientists have worked out a plan for classifying the billions of individual animals on the earth.

The main divisions of the animal kingdom are called phyla.

Phyla are divided into classes, classes into orders, orders into families, families into genera, and genera into species.

Every animal has a scientific name which is made up of a genus name and a species name.

About 95 per cent of all species of animals are invertebrates—animals without backbones.

The vertebrates form only a part of the phylum of chordates, although the largest and most conspicuous animals are vertebrates.

All vertebrates have a backbone made up of vertebrae, through which a nerve cord passes.

All the animals of today are believed to have come from very simple animals of long ago.

The insects rank highest among the invertebrates, the mammals highest among the vertebrates.

Possible Approach

Read with the class the first six paragraphs of the section. Then examine the chart on the inside front cover. Point out that the chart shows no divisions smaller than classes. Let the group find from page 7 that the vertebrates are a subphylum of the chordates.

Activities

1. Follow suggestion No. 2 on page 36 of the unitext.
2. Follow suggestion No. 3 on page 36 of the unitext.
3. Follow suggestion No. 4 on page 36 of the unitext.
4. Follow suggestion No. 5 on page 36 of the unitext.
5. Follow suggestion No. 9 on page 36 of the unitext.
6. Show with a graph of some kind how the different phyla compare in number of species.
7. Cut out pictures of animals from magazines. Sort them into groups.
8. Make a large wall chart similar to the small one on page 2. Substitute pictures of other members of the phyla for those used in the chart on page 2.
9. Animals are classified into species, orders, families, classes, and phyla according to their structure. Animals can also be divided into groups in other ways. They can, for example, be grouped according to their habitats. Try on that basis to work out a classification of all the animals pictured in this book. They can also be grouped according to their food. Try such a group-

ing with the animals pictured in the book. Think of as many other ways as you can in which these animals might be grouped.

Study Problems and Exercises

1. Fill in the blank spaces with the word that is being defined.

(*species*)	A group of animals differing only slightly.
(*genus*)	A group of species.
(*family*)	A group of genera.
(*order*)	A group of families.
(*class*)	A group of orders.
(*phylum*)	A group of classes.

2. Cross out each of the following statements that is not true.

There are more species than genera.
~~There are more phyla than families.~~
There are more genera than families.
There are more families than orders.
~~There are more orders than genera.~~
There are more orders than classes.
~~There are more classes than families.~~
There are more classes than phyla.

3. Fill in the blank spaces:

The bobcat belongs to the species of (*bobcats, or rufus*).
The bobcat belongs to the genus of (*lynxes, or Lynx*).
The bobcat belongs to the family of (*cats, or Felidae*).
The bobcat belongs to the order of (*carnivores*).
The bobcat belongs to the class of (*mammals*).
The bobcat belongs to the phylum of (*chordates*).

4. What is the scientific name of each of the following animals?

Bobcat (*Lynx rufus*) House cat (*Felis domestica*) California bobcat (*Lynx rufus californicus*) Lion (*Felis leo*)

5. Why does the California bobcat have a third word in its scientific name? (*P.6, ¶ 3*)

6. How can you tell by looking at their scientific names that the bobcat and the house cat are not so closely related as the house cat and the lion? (*P. 6, ¶ 5*)

7. Fill the blanks in these sentences:

Sciurus niger is a kind of (*squirrel*).

Bufo americanus is a kind of (*toad*).

Epiaeschna heros is a kind of (*dragonfly*).

8. What is the difference between vertebrates and invertebrates? (*P. 7, ¶ 1*)

9. List at least three things shown by the animal tree on page 2. (*P. 7, ¶ 3*)

III. PROTOZOA (pages 8-9)

Core Ideas

Protozoa are one-celled animals.

The one cell of a protozoan must carry on all the activities which larger animals have to carry on in order to stay alive.

Protozoa live in water or in very moist places.

Both sexual and asexual reproduction are found among the protozoa.

Protozoa are both helpful and harmful.

Possible Approach

Call the attention of the class to the pictures on pages 8 and 9. Explain that the animals in the pictures are all common but that most people have never seen them. Ask for possible explanations. Check by reading the first paragraph of the section.

Activities

1. Follow suggestion No. 8 on page 36 of the unitext.

2. Obtain some amebas from a biological supply house. Observe the activities of the amebas under the microscope.

3. Place some dry hay or dry grass in a jar of water and let it stand in a dark place for about a week. Then examine a drop of the water under the microscope. It should contain living paramecia. Study their activities.

4. Examine some prepared slides of amebas and paramecia.

5. Read more about protozoa in "Living Jewels of the Sea" in the September, 1927, issue of the *National Geographic Magazine*. See also *Natural History* for December, 1942.

Study Problems and Exercises

1. How does an ameba do the following things?

Move through the water. (*Sends out pseudopods.*)

Get food. (*Surrounds it by means of pseudopods.*)

Get oxygen. (*Takes it in through the cell membrane.*)

Get rid of wastes. (*Sends them out through the cell membrane.*)
Reproduce. (*Simply divides in two.*)
Protect itself from lack of water. (*Forms a covering around itself.*)

2. In what four ways is a paramecium different from an ameba? (*P. 9, ¶ 3*)

3. Tell at least one reason why it is important to know about protozoa. (*P. 9, ¶ 5*)

IV. SPONGES (page 10)

Core Ideas

All sponges live in water.

Sponges are many-celled animals made up of cells of several kinds.

Both sexual and asexual reproduction are found among sponges.

Sponges have remarkable powers of growing anew parts that have been lost.

The sponges of commerce are skeletons of these animals.

Possible Approach

Show a commercial sponge. Ask what it has to do with the unit being studied. Check suggestions made by reading the first paragraph of the section.

Activities

1. Examine specimens of horny, chalky, and glassy sponges. If not available in your school laboratory, perhaps you can see them at a natural history museum.

2. Read more about sponges in the February, 1937, issue of the *National Geographic Magazine*. The article is called "Denizens of Our Warm Atlantic Waters."

Study Problems and Exercises

1. In what two ways are sponges like plants? (*P. 10, ¶ 1*)

2. Give at least one reason for classifying them as animals. (*They have all the different kinds of cells, except one kind, found in higher animals.*)

3. In what one important way are sponges different from protozoa? (*They are made of many cells.*)

5. Why were sponges given the name Porifera? (*P. 10, ¶ 3*)

6. How do sponges get food and oxygen? (*P. 10, ¶ 3*)

7. In what three ways can sponges reproduce? (*P. 10, ¶¶ 4 and 6*)

V. COELENTERATES (page 11)

Core Ideas

All coelenterates are water animals.

Coelenterates have radial symmetry.

Many species of coelenterates go through two distinct stages in their life-history—a polyp stage and a medusa stage.

Coelenterates of many kinds live in colonies.

Both sexual and asexual reproduction are found among the coelenterates.

Possible Approach

Call attention to the pictures at the top of page 11. Point out that the animals pictured are all coelenterates. Read the first five paragraphs to find out what the distinguishing features of the group are.

Activities

1. If possible obtain some hydras from a biological supply house. Watch their activities under the low power of a microscope.

2. Examine prepared slides of hydras.

3. Look in college textbooks for diagrams of the stinging cells of coelenterates. Try to find out how they work.

4. If you have a public aquarium in your community, visit it and find out whether they have some living sea anemones.

5. Read more about coelenterates in ANIMALS OF THE SEASHORE, another unitext in this series.

6. Read more about coelenterates in "The Life of the Moon-Jelly" in the August, 1926, issue of the *National Geographic Magazine*.

7. Examine a collection of coral.

8. Find pictures of coral atolls and find out how such atolls are formed.

Study Problems and Exercises

1. Name five examples of coelenterates. (*P. 11, ¶ 1*)

2. Underline each of the following characteristics which is true of coelenterates but not true of protozoa or sponges.

They are made of many cells.
They have nerve cells in addition to all the other chief kinds of animal cells.
New animals may branch from older ones.
Oxygen is taken in from the surrounding water.
They capture prey by means of poison darts.
Some stay in one place all their lives.
They have tentacles armed with stinging cells.
They can reproduce sexually.
Some swim freely in the water.
Some have skeletons.

3. Draw a picture to show that you know what is meant by "radial symmetry." (*P. 11, ¶ 5*)

4. Some coelenterates go through two stages. Describe the two stages. (*P. 11, ¶ 6*)

VI. Comb Jellies (page 12)

Core Ideas

All comb jellies are marine animals.

Comb jellies have radial symmetry.

The animals in this group differ from all other animals in having tiny plates arranged in rows called combs.

Comb jellies can grow anew parts that have been lost.

Sexual reproduction is the rule among the comb jellies, but each individual produces both eggs and sperms.

Possible Approach

Identify the animals pictured at the top of page 12 as comb jellies. Read the first two paragraphs to find out what the distinguishing features of this group are.

Activities

1. Look in books about animals of the seashore for common names of various species of comb jellies.

2. If you are on the seashore during the summer and fall, watch for comb jellies washed up on the beach.

Study Problems and Exercises

1. Tell two ways in which comb jellies differ from coelenterates. (*They have combs, which coelenterates do not have. They do not have stinging cells on their tentacles as coelenterates have.*)
2. How do comb jellies swim? (*P. 12, ¶ 3*)
3. How do they get their food? (*P. 12, ¶ 4*)
4. What is the most common method of reproduction? (*Sexual.*)
5. Since there are no male or female comb jellies, how can sexual reproduction occur? (*Each animal produces both eggs and sperms.*)
6. "It was a very dark night, but I could see many comb jellies in the sea near shore." Could this quotation be true? Explain. (*P. 12, ¶ 1*)

VII. ECHINODERMS (page 13)

Core Ideas

All echinoderms are marine animals.

The distinctive characteristic of echinoderms is an internal system of water canals connected with tube feet.

Adult echinoderms show radial symmetry, but larval echinoderms are bilaterally symmetrical.

Larval echinoderms are much like the larval forms of the lower chordates.

Possible Approach

Show skeletons of a starfish, a sea urchin, and a sand dollar. Ask the class to try to find from the skeletons some characteristic which these three animals have in common. (*Radial symmetry.*) Do they differ in this way from the coelenterates and comb jellies? (*No.*) Find out what are, then, the characteristics which set them apart from other animals.

Activities

1. Read more about echinoderms in "Sea Creatures of Our

Atlantic Shores" in the August, 1936, issue of the *National Geographic Magazine.*

2. Read more about echinoderms in ANIMALS OF THE SEASHORE.

3. Examine the skeletons of starfish and other echinoderms found in your school laboratory.

4. Visit the echinoderm exhibits in your natural history museum.

Study Problems and Exercises

1. Why is "echinoderms" a suitable name for the phylum which includes the starfish, sea urchin, and sand dollar? (*P. 13, ¶ 2*)

2. What is the distinguishing characteristic of this phylum? (*P. 13, ¶ 4*)

3. Since echinoderms do not look at all like the lower chordates or the vertebrates, why are they put on the same branch? (*P. 13, ¶ 5*)

4. Underline the correct answer:

Do echinoderms differ from comb jellies in

habitat?	Yes	[✓ No]
way of moving?	[✓ Yes]	No
symmetry as adults?	Yes	[✓ No]
symmetry in early stage?	[✓ Yes]	No
means of catching food?	[✓ Yes]	No

VIII. WORMS (pages 14-15)

Core Ideas

The three chief worm phyla are the flatworms, the roundworms, and the segmented worms.

All worms show bilateral symmetry.

Some worms do much harm, but some are helpful.

The segmented worms rank highest among the worms; they are considered to be about halfway between the simplest animals and the most complex ones.

Roundworms and segmented worms have lost the power of asexual reproduction.

Possible Approach

Ask the class to find "worms" in the chart on the inside cover and on the "tree" on page 2. Emphasize the fact that worms do not make up just one phylum. Find from the first paragraph of the text that the three worms pictured on page 14 represent three different phyla.

Activities

1. Try to obtain some planaria by placing a piece of liver tied to a string into a fresh-water stream. If planaria are present they will come and attach themselves to the liver, which they eat.

2. Try raising planaria. Keep them in small shallow bowls of fresh water. Feed them small pieces of liver. Do not allow liver to remain in the water for more than an hour or two, for decaying meat will kill the planaria. Change the water daily. Keep the animals in a shady but warm place.

3. Cut some planaria in two pieces. Then take care of them as described in suggestion No. 2. Watch them daily until they have grown new heads or tails.

4. Examine prepared slides of tapeworm and roundworm.

5. Place some soil in a small quantity of water and allow it to stand for a day or two. Examine the water under the microscope. Among other living things you will probably see some wiggling roundworms.

6. Examine earthworms. Look for the segments. In biology books find diagrams of the various systems of organs in the earthworm's body.

7. In reference books read more about the economic importance of earthworms.

Study Problems and Exercises

1. Give two reasons for the fact that worms are generally despised. (*P. 14, ¶ 2*)

2. In the blank space write the phylum to which the worm suggested by each of the following sentences belongs.

(*Segmented worms*) A worm that is beautiful and like a flower.

(*Roundworms*)	A worm whose scientific name means "American killer."
(*Roundworms*)	A worm found in uncooked pork.
(*Roundworms*)	A worm which may cause one part of the body to grow very large.
(*Flatworms*)	A tapeworm.
(*Segmented worms*)	A worm which sucks the blood of animals.
(*Segmented worms*)	A worm that is helpful in making soil fertile.

3. In front of each of the following sentences place:
an *F* if the sentence is true of flatworms.
an *R* if the sentence is true of roundworms.
an *S* if the sentence is true of segmented worms.
a combination of the above letters if true of two of them.
an *N* if true of none.
an *A* if true of all.

(*F*) They are the simplest animals with a definite head.
(*S*) Their bodies are divided into sections.
(*A*) They have definite organs.
(*A*) They develop from fertilized eggs.
(*N*) They have backbones.
(*F*) They can divide in two to form two new worms.
(*R*) They are threadlike in appearance.
(*R, S*) They are more highly developed than planaria.
(*S*) They probably rank higher than the mollusks.
(*S*) They are more highly developed than the roundworms.
(*A*) They are more highly developed than jellyfish.
(*N*) They can make their own food.

4. Why is bilateral symmetry good for fast-moving animals? (*P. 14, ¶ 4*)

5. Give one reason why the earthworm is not placed in the same phylum with the roundworms or with the planaria. (*P. 15, ¶ 3*)

6. Which do you suppose are more closely related to the insects—earthworms or planaria? Give a good reason for your answer. (*Earthworms and insects are segmented.*)

IX. MOLLUSKS (pages 16-17)

Core Ideas

Mollusks are found in fresh water, in salt water, and on land.

The three main classes of mollusks are the gastropods, the cephalopods, and the pelecypods.

As a rule mollusks have soft bodies and hard shells.

Only sexual reproduction is found among the mollusks.

Mollusks are of great economic importance.

Possible Approach

Show a collection of gastropod and pelecypod shells. Point out that they are mollusk shells and ask the class to locate "mollusks" on the chart on the inside front cover and on the "tree" on page 2. Find some basis for dividing the shells into two groups. Find out from the text on page 16 that gastropods are univalves and pelecypods bivalves.

Activities

1. Obtain a clam from a store where seafoods are sold, or try to find one in a fresh-water stream. Pry open the shell and examine the soft body. Try to locate the mantle just inside the shell; the thick muscular foot; the delicate gills which hang at the sides of the body like pages of a book. Try to identify as many parts of the body as you can.

2. Watch a large snail in an aquarium. Notice how it glides along the glass by means of its muscular foot. Notice also the movement of its tentacles and how it takes in food.

3. Obtain a squid from a seafood store. Ask for one that has not already been prepared for cooking. Observe the tentacles and the suckers on them, the large eye which looks much like a human eye, and the streamlined body. Cut through the muscular body. Inside you will find the feathery gills and other organs. Locate also the penlike shell imbedded in the body. Locate the ink sac situated in the region between the gills.

4. Read more about mollusks in ANIMALS OF THE SEASHORE another unitext.

5. Read also "Marauders of the Sea" in the August, 1935, issue of the *National Geographic Magazine*.

6. Assemble a collection of mollusk shells. Label them. Use a shell guide if one is available.

Study Problems and Exercises

1. Into what three parts is a mollusk's body divided? (*P. 16, ¶ 2*)

2. Give another name for each of the following groups of mollusks:
Stomach-footed mollusks (*Gastropods*)
Hatchet-footed mollusks (*Pelecypods*)
Head-footed mollusks (*Cephalopods*)

3. How do gastropods do each of the following things?
Get oxygen (*With gills or lungs.*)
Break food into small pieces (*By means of the radula.*)
Reproduce (*Only through the union of egg and sperm.*)
Make their shell (*It is secreted by the mantle.*)

4. Of the underlined words cross out any which do not belong in these sentences:

Pelecypods, ~~gastropods,~~ and ~~cephalopods~~ have a bivalve shell.

~~Pelecypods~~, ~~gastropods~~ ,and cephalopods have the best invertebrate eyes.

Gastropods, ~~pelecypods,~~ and cephalopods have a radula.

Land gastropods and ~~marine gastropods~~ have a kind of lung for breathing.

Pelecypods, gastropods, and cephalopods have soft bodies.

Pelecypods, gastropods, and cephalopods have a mantle.

Pelecypods, ~~gastropods~~ , and ~~cephalopods~~ have siphons for water to enter and leave the mantle cavity.

~~Snails,~~ squids, and octopuses have arms which bear suckers.

Gastropods and nautiluses have coiled shells.

X. Crustaceans (pages 18-19)

Core Ideas

The crustaceans make up one class of arthropods, by far the largest phylum in the animal kingdom.

All arthropods are segmented, they all have jointed appendages, and they all have an outside skeleton of chitin.

Crustaceans are chiefly marine animals.

Most crustaceans have gills and two pairs of feelers—a combination not found among other arthropods.

Crustaceans are important economically.

Possible Approach

Ask the class to find out what they can about the arthropods from the chart on the inside cover and the "tree" on page 2. Then let them find from the first paragraph on page 18 the distinguishing characteristics of this large group of animals.

Activities

1. Closely examine a crayfish or lobster. Notice its chitinous skeleton, its jointed appendages, its two pairs of feelers, its eyes and mouth-parts, swimmerets and tail-fin. Notice how the head and thorax are joined to form the cephalo thorax.
2. Obtain some crayfish and keep them in a shallow aquarium. Observe their activities.
3. Read more about crustaceans in the following articles in the *National Geographic Magazine:* "Crabs and Crablike Curiosities of the Sea," July, 1928; "Sea Creatures of Our Atlantic Shores," August, 1936; "Denizens of Our Warm Atlantic Waters," February, 1937; "Where Nature Runs Riot," June, 1940.
4. Read more about barnacles in ANIMALS OF THE SEASHORE.
5. Get from a biological supply house some very tiny crustaceans such as *Daphnia* and examine them with a microscope.

Study Problems and Exercises

1. In what three ways are all arthropods alike? (*P. 18, ¶ 1*)
2. What two characteristics set the crustaceans apart from other arthropods? (*P. 18, ¶ 3*)
3. Name the appendages found on each of the following body parts of the lobster: head, thorax, abdomen. (*P. 19, ¶ 1*)
4. What work does each of the following appendages do: first pair of legs, other legs, swimmerets? (*P. 18, ¶ 4, and p. 19, ¶ 1*)
5. How does a lobster grow larger? (*P. 19, ¶ 3*)
6. Name five other crustaceans. (*P. 18, ¶ 2*)

XI. MYRIAPODS (page 20)

Core Ideas

This group of arthropods is made up of the centipedes and millipedes—all many-legged animals.

Both centipedes and millipedes are land animals.

Myriapods are of little importance to us.

Possible Approach

Lead the class to recall that the myriapods make up one of the classes of arthropods. Call attention to the two myriapods pictured on page 20 and ask for an easy way of distinguishing them from the crustaceans. (*Their many legs.*) Find out from the text what the word myriapod means.

Activities

1. Find some centipedes if possible. Notice their chitinous skeleton and jointed legs. Count the number of legs.

2. Find some millipedes if possible. Compare them with the centipedes. Count the number of legs.

Study Problems and Exercises

1. Why are centipedes and millipedes often put in the same class? (*P. 20, ¶ 1*)

2. In front of each of the following statements place
an *M* if it is true of millipedes but not centipedes.
a *C* if it is true of centipedes but not millipedes.
a *B* if it is true of both.
(*C*) They have one pair of legs on most segments.
(*M*) They have two pairs of legs on most segments.
(*C*) They have poison claws.
(*B*) They live in dark, damp places.
(*C*) They eat animal food.
(*M*) They eat plant food.
(*B*) They lay eggs.
(*B*) They breathe through branched tubes.

XII. Arachnids (page 21)

Core Ideas

Arachnids, a third group of arthropods, are distinguished by having four pairs of legs and no antennas.

Although popularly supposed to be our enemies, most arachnids are harmless and a few are helpful.

Possible Approach

Point out that arachnids are often mistakenly called insects. Ask the class to compare the spider pictured on page 21 with the many insects pictured on page 23 and try to find some easily seen way in which the spider differs from the insects. (*Eight legs.*) Find out by reading the first two paragraphs on page 21 whether all arachnids are alike in this respect.

Activities

1. Find as large a spider as you can. Notice its chitinous exoskeleton, its jointed legs, the number of eyes, the poison fangs, the spinnerets. Count the number of legs.
2. Find other arachnids. Compare them with the spider.
3. Read more about spiders in Spiders, another unitext.

Study Problems and Exercises

1. Underline all the arachnids in the following list.

Water fleas
Scorpions
Sow bugs
Ticks
Spiders
Grasshoppers
Crabs
Daddy-longlegs
Centipedes
Mites
Clams
Squids

2. Mark these sentences true or false:

X (1) All arachnids have compound eyes.
X (2) All arachnids have two pairs of antennas.
X (3) All arachnids have six legs.
C (4) The body of an arachnid is divided into a cephalothorax and an abdomen.
C (5) Some arachnids breathe by means of book lungs.
X (6) All arachnids breathe by means of air tubes.
X (7) All arachnids have poisonous stings.

C (8) Spiders are meat-eaters.
C (9) Arachnids generally have from two to twelve simple eyes.
C (10) Spiders make up the largest group of arachnids.
X (11) All arachnids spin webs.

XIII. INSECTS (pages 22-24)

Core Ideas

Insects make up the largest group of arthropods.

More than half of all the species of animals are insects.

Insects differ from other arthropods in having three distinct body regions, three pairs of legs, and one pair of antennas.

Most insects have wings and compound eyes.

Insects are very widely distributed.

Different insects are fitted for living in different habitats.

Small insects during their life-histories go through a series of changes called a complete metamorphosis.

Insects both harm and help us in many ways.

Possible Approach

Show a collection of mounted insects or of colored pictures of insects. Try to see ways other than the number of legs in which all the insects shown are alike. Check the ideas advanced by reading the first four paragraphs of the section.

Activities

1. Obtain a grasshopper. Notice its chitinous exoskeleton, its jointed legs, the number of legs, the number of body divisions, the antennas, the compound eyes, the wings, the spiracles on the abdominal segments, the mouth parts.
2. Follow suggestion No. 6 on page 36 of the unitext.
3. Follow suggestion No. 10 on page 36 of the unitext.
4. Make a collection of insects. For instructions see *Field Book of Insects,* by Frank E. Lutz, or the booklet "How To Collect and Preserve Insects," which can be obtained from the American Museum of Natural History for ten cents.
5. Read more about insects in INSECTS AND THEIR WAYS,

Insect Societies, and Insect Friends and Enemies, three other unitexts in this series.

6. Read more about insects in "Exploring the Wonders of the Insect World" in the July, 1929, issue of the *National Geographic Magazine.*

Study Problems and Exercises

1. Underline each of the following statements which is true of *all* insects:

They have six legs.
They breathe by means of spiracles.
They have wings.
They go through a complete metamorphosis.
They have a chitinous exoskeleton.
They are caterpillars when young.
They come from fertilized eggs.
They have one pair of antennas.
The body is divided into three distinct parts.

2. Write before each characteristic named below the name of an insect order which has that characteristic:

(*Lepidoptera*)	Have scaly wings.
(*Orthoptera*)	Have biting mouth-parts.
(*Diptera*)	Have two wings.
(*Hymenoptera*)	Have societies much like ours.

3. List the stages through which a butterfly goes in its development. (*P. 24, ¶ 3*) What is this kind of development called? (*Complete metamorphosis*)

4. Name the insect order to which these insects belong: (See chart on p. 23.) Cecropia moth, monarch butterfly, potato beetle, praying mantis, katydid, cockroach, grasshopper, honeybee, dragonfly, termite, locust, ant-lion, paper wasp, bumblebee, mosquito, housefly, dung beetle, cricket, ant, walking stick.

5. On the chart as indicated on the next page, after each characteristic named put a check under the name of each group of animals having that characteristic:

Characteristic	Flatworms	Sponges	Coelenterates	Protozoa	Roundworms	Jointed Worms	Mollusks	Echinoderms	Arthropods	Comb Jellies
Are built of protoplasm	x	x	x	x	x	x	x	x	x	x
Have jointed legs									x	
Have tube feet								x		
Some have a radula							x			
Must have oxygen	x	x	x	x	x	x	x	x	x	x
Have threadlike bodies					x					
Are made of only one cell				x						
Have stinging cells			x							
Their bodies are covered with pores		x								
Are made of cells	x	x	x	x	x	x	x	x	x	x

XIV. Fishes (pages 25-26)

Core Ideas

Fishes rank lowest of the five groups of vertebrates.

Fishes are cold-blooded animals with fins and gills.

All fishes live in water.

Most fishes lay eggs, but some are live-bearing.

There are four main groups of fishes, the largest and best known of which are the bony fishes.

Fishes are of great economic importance.

Possible Approach

Have fish of one or more kinds in an aquarium and lead the class to identify them as fish. Call attention to the place of fishes on the "tree" on page 2. Find out from the chart on the inside cover how many species there are. Ask the class what characteristics enabled them to identify the animals in the aquarium as fishes. Find out by reading the first four paragraphs of the section whether the characteristics named are common to all fishes.

Activities

1. Obtain a fish from your school biology laboratory or from a fish market. Try to locate all the parts of the fish mentioned in the text.

2. If you have a public aquarium in your community, look there for lungfish, skates, rays, seahorses, and other interesting fishes mentioned in the text.

3. Read more about fishes in FISHES, another unitext.

4. Read more about strange fishes in "Half Mile Down" in the November, 1943, issue of the *National Geographic Magazine.*

Study Problems and Exercises

1. What does it mean to say that an animal is cold blooded? (*P. 25, ¶ 2*)

2. For what two reasons are seahorses classified as fish? (*P. 25, ¶ 4—they have fins and gills.*)

3. What is unusual about each of the following?

A fish's eyes (*P. 25, ¶ 5*)
A fish's ears (*P. 25, ¶ 5*)
A fish's heart (*P. 25, ¶ 5*)
The seahorse (*P. 25, ¶ 4*)
Some tropical fish (*P. 26, ¶ 2*)

4. What enables some fish to sink or rise in the water? (*P. 25, ¶ 4*)

5. To what group of fishes do the following belong?

Herrings and seahorses.	(*Bony fishes*)
Fishes that can take oxygen from air as well as from water.	(*Lungfishes*)
Fishes that have paired fins, jaws, and skeletons of cartilage.	(*Sharks and rays*)
Fishes that have no scales, no jaws, and no paired fins.	(*Hagfishes and lampreys*)

XV. AMPHIBIANS (pages 27-28)

Core Ideas

Amphibians get their name from the fact that, as a rule, they live part of their lives under water and part on land.

When young, amphibians are much like fishes, but they lose a great deal of this resemblance as they grow up.

Amphibians are cold blooded.

Unlike the fishes below them and the reptiles above them, amphibians have no scales.

The amphibians of today are divided into three groups: toads and frogs, newts and salamanders, and caecilians.

Most amphibians lay eggs, but at least one species is live-bearing.

As a group amphibians are far less important enonomically than fishes.

Possible Approach

Show one or more amphibians. Identify them as amphibians and then find by reading the first paragraph of the section why the name "amphibians" is appropriate for the group.

Activities

1. Obtain a toad or frog. Observe as many of its characteristics as you can.
2. In a public aquarium or in a store where goldfish and other aquarium animals are sold look for other kinds of amphibians.
3. Read more about amphibians in TOADS AND FROGS, another unitext.
4. In spring look for frog eggs in a pond or stream. Keep them in the water from the pond or stream and place them in a warm, shady place. Place water plants of some kind in the container. Watch the eggs develop into tadpoles and then into frogs.

Study Problems and Exercises

1. Tell four ways in which early amphibians differed from all animals that had lived before them. (*P. 27, ¶ 2*)
2. In what one easy way can you tell an amphibian from a fish or a reptile? (*P. 27, ¶ 3*)
3. Name a group of amphibians that have, when grown,
    no legs and no tail. (*Caecilians*)
    legs, but no tail. (*Toads and frogs*)
    legs and a tail. (*Newts and salamanders*)
4. Why is the mudpuppy regarded as one of the exceptions to the general amphibian plan of life? (*P. 27, ¶ 5*)

5. Fill in the blank spaces:

The leopard frog is a typical amphibian. The female of this species lays *(thousands)* of eggs in a stream or pond. They are immediately *(fertilized)*. Within a few days they hatch into *(tadpoles)*. These undeveloped frogs swim by means of their *(tails)*, breathe by means of *(gills)*, and eat *(water plants)*. Before they become adult land animals they lose their *(tails)* and their *(gills)* and develop *(legs)* and *(lungs)*.

6. Name four means of protection found among amphibians. *(P. 28, ¶ 4)*

XVI. Reptiles (pages 29-30)

Core Ideas

Although once the earth's ruling animals, reptiles are now a rather inconspicuous group.

Reptiles are cold blooded.

In contrast with adult amphibians, reptiles breathe with lungs all their lives and are, as a rule, covered with scales.

For the most part reptiles are land animals.

There are four orders of present-day reptiles.

Some reptiles lay eggs; some are live-bearing.

Reptiles are of far less economic importance than fishes, birds, or mammals.

Possible Approach

Show pictures of extinct reptiles and of reptiles of today. Identify them all as reptiles and let the class try to group them into two groups. Having grouped them into ancient and modern reptiles, read the first paragraph on page 29 to compare the role ancient reptiles played with that played by reptiles now.

Activities

1. Obtain turtles, lizards, and snakes of one or more kinds. Observe as many of their characteristics as you can.

2. Visit a zoo to see the reptiles there.

3. Visit a natural history museum to see fossils of reptiles of the past.

4. Read more about reptiles in Reptiles, another unitext.

Study Problems and Exercises

1. List three ways in which reptiles differ from amphibians. (*P. 29, ¶¶ 3 and 4*)

2. Name at least one way in which fishes, amphibians, and reptiles are alike. (*Are cold blooded.* Or: *Have backbones.*)

3. Name the order or suborder of reptiles indicated by each of the following clues:

Contains reptiles which have no legs and no eyelids but which have jaws that open very wide.	(*Snakes*)
Contains only one species.	(*Tuatara*)
Contains the largest of the reptiles of today.	(*Alligators and crocodiles*)
Contains only land forms.	(*Lizards*)
Contains the only marine members of the class.	(*Turtles*)

4. Why are reptiles important to us? (*P. 30, ¶ 5*)

XVII. Birds (pages 31-32)

Core Ideas

Feathers are the distinguishing characteristic of birds.
Birds are warm-blooded animals.
All birds come from eggs; none are live-bearing.
The typical bird's body is well adapted for flight.
Many birds migrate long distances.
The perching birds make up by far the largest order of birds.
Birds rank high in economic importance.

Possible Approach

Show colored pictures of a number of birds. Ask the class to pick out characteristics which they can see are common to all the birds pictured. Discuss the question of which of these characteristics is most helpful in identifying the animals shown as birds. Check by reading the first paragraph on page 31.

Activities

1. Closely observe a chicken, a canary, or any other common bird. Observe as many of its characteristics as you can.

2. Keep a record of all the different kinds of birds you see

in some convenient period of time. Try to find out to what order each belongs.

3. Read more about birds in Birds, another unitext.

4. Visit the bird section of a natural history museum. Observe how the structures (such as bills, feet, legs, claws, etc.) of the birds fit them to their environment.

5. Hatch some chicken or duck eggs in an incubator. Watch the baby birds develop.

6. Make a large chart similar to the one on page 32, using colored pictures.

Study Problems and Exercises

1. List two characteristics which make the birds different from all the animals below them on the animal tree. *(P. 31, ¶ 2)*

2. Identify each of the following:

The food-grinding organ of birds.	*(Gizzard)*
The food-storage organ of birds.	*(Crop)*
The temperature above which bird's eggs must be kept in order to hatch.	*(99° F.)*
The feathers with which ducks and chickens are covered when hatched.	*(Down)*
A projection of the breastbone to which strong wing muscles are attached.	*(Keel)*

3. List four special adaptations of the bird's body for flight. *(P. 32, ¶ 2)*

4. What characteristics do the birds in each of the following groups have in common?

Ducks, geese, and swans	*(Webbed feet)*
Herons, storks, flamingos, bitterns	*(Long legs for wading)*
Vultures, hawks, and eagles	*(Sharp claws for catching prey)*
Swifts and hummingbirds	*(Poorly developed feet)*
Kingfishers and hornbills	*(Bills for spearing fish)*
Perching birds	*(Feet adapted for perching; songs)*

XVIII. Mammals (pages 34-36)

Core Ideas

Mammals, like birds, are warm blooded.

Mammals feed their young with milk from mammary glands.

Hair is a distinguishing characteristic of mammals.

With the exception of the monotremes, mammals are live-bearing.

The live-bearing mammals are either marsupials (a small group), or placental mammals.

All mammals have well developed systems of organs.

People are mammals.

The group of mammals includes all our fur-bearing animals and many of the animals we have tamed.

Possible Approach

Ask the class to name ten domesticated animals. Draw a circle around all the mammals named without telling what the circle stands for. Get similar lists of animals larger than a dog, animals commonly seen at a zoo, and fur-bearing animals. Circle the mammals in each list. Ask what the circles stand for. Ask, too, what conclusion they can draw from the number of circles. Check the conclusion by reading the first paragraph of the section.

Activities

1. Follow suggestion No. 1 on page 36 of the unitext.
2. Visit a zoo. Make a list of all the mammals you see there. Check your list against the chart of mammals on the inside back cover of the unitext.
3. Visit the mammal sections of a natural history museum. Look for monotremes, shrews, anteaters, manatees, and others of the less common mammals.
4. Look in high school or college textbooks on zoology for diagrams of the four-chambered mammalian heart and other parts of mammalian anatomy. Compare them with similar diagrams of the anatomy of lower animals.
5. Raise hamsters, mice, or some other small mammal.

Study Problems and Exercises

1. In the blank spaces write the word mammal if the char-

acteristic mentioned is possessed only by mammals. If not possessed only by mammals, write the name of one other kind of animal that has the characteristic.

A four-chambered heart	(*Bird*)
Milk glands	(*Mammal*)
A diaphragm	(*Mammal*)
Systems of organs	(*Frog—or any of many others.*)
Warm blood	(*Bird*)
Two sets of teeth	(*Mammal*)
Four legs	(*Turtle—or another example.*)
A placenta	(*Mammal*)
Live birth	(*Tropical fish—or another example.*)
Lungs during entire life	(*Reptiles or birds*)
Hair	(*Mammal*)

2. Since monotremes lay eggs, why are they placed in the class with mammals? (*They have milk glands.*)

3. How are young placental mammals nourished before birth? (*P. 35, ¶ 5*)

4. Why are mammals one of the most important groups of animals? (*P. 34, ¶ 1*)

Summary Exercises

1. Below is a list of animal characteristics. In the space provided write the name of an animal group having the characteristic. Indicate also whether the group you mention is a phylum, subphylum, class, or order.

A threadlike body	(*Roundworms, a phylum*)
A backbone	(*Vertebrates, a subphylum*)
A water-canal system	(*Echinoderms, a phylum*)
The best invertebrate eye	(*Cephalopods, a class*)
One-celled bodies	(*Protozoa, a phylum*)
Tentacles armed with stinging cells	(*Coelenterates, a phylum*)
Six legs	(*Insects, a class*)
A chitinous exoskeleton	(*Arthropods, a phylum*)
Eight legs	(*Arachnids, a class*)
Pouches for young	(*Marsupials, an order*)
Gills and two pairs of feelers	(*Crustaceans, a class*)
A backbone, a shell, and scales	(*Turtles, an order*)

2. In each of the following scratch out the word or phrase which does not belong with the others. In the blank space tell why.

1) jellyfish
silverfish
crayfish
starfish
~~hagfish~~
(*Is a vertebrate, or is a fish.*)

2) stinging cells
tentacles
radial symmetry
polyp stage
~~pseudopods~~
(*Not a characteristic of coelenterates.*)

3) ~~sea horse~~
sea lily
sea urchin
sea cucumber
starfish
(*Is a fish, or is a vertebrate.*)

4) chitin
~~lungs~~
six legs
spiracles
jointed legs
(*Not an insect characteristic.*)

5) shark
~~whale~~
perch
lamprey
seahorse
(*Is a mammal, not a fish.*)

6) ~~cellulose cell walls~~
as a rule must have ready-made food
respond quickly to stimuli
as a rule can move from place to place
have nerve cells
(*Not an animal characteristic.*)

7) shrimp
centipede
butterfly
honeybee
~~leech~~
(*Not an arthropod.*)

8) species
order
~~grade~~
phylum
class
(*Not used in animal classification.*)

9) swan
hornbill
owl
~~duckbill~~
plover
(*Not a bird.*)

10) Porifera
~~Lepidoptera~~
Platyhelminthes
Annelida
Chordata
(*Not a phylum.*)

11) diaphragm
mammary glands
hair
~~gills~~
four-chambered heart
(*Not characteristic of mammals.*)

12) egg
pupa
~~ameba~~
larva
adult
(*Not a stage in complete metamorphosis.*)

3. Below there are a numbered list of characteristics and a list of animals. In the blank space after each animal's name write the number of each listed characteristic possessed by that animal.

1. Protoplasm
2. Mantle
3. Gills
4. Keel
5. Spiracles
6. Cellulose
7. Siphon
8. Cephalothorax
9. Placenta
10. Spinnerets
11. First definite head
12. Tube feet
13. Exoskeleton
14. Radula
15. Smooth, moist skin
16. Pseudopods
17. Radial symmetry
18. Bilateral symmetry
19. Segments
20. Diaphragm
21. Chitin
22. Odd number of toes
23. Hair
24. Hollow bones
25. Asexual reproduction
26. Grow from zygotes
27. A porous body
28. Lays eggs with shells
29. Stinging cells
30. Eight legs

Robin (*1, 4, 18, 19, 24, 26, 28*)
Grasshopper (*1, 5, 13, 18, 19, 21, 26*)
Sponge (*1, 25, 26, 27*)
Ameba (*1, 16, 25*)
Lobster (*1, 3, 8, 13, 18, 21, 26*)
Snail (*1, 2, 3, 14, 18, 26*)
Sea anemone (*1, 17, 25, 26, 29*)
Centipede (*1, 13, 18, 19, 21, 26*)
Horse (*1, 18, 19, 20, 22, 23, 26*)
Squid (*1, 2, 3, 14, 18, 26*)
Turtle (*1, 18, 26, 28*)
Planaria (*1, 11, 18, 25, 26*)
Spider (*1, 8, 10, 13, 18, 21, 26, 30*)
Starfish (*1, 12, 17, 26*)

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Clam (*1, 2, 3, 7, 18, 26*) Perch (*1, 3, 18, 26*)
Earthworm (*1, 18, 19, 26*) Frog (*1, 15, 18, 26*)

4. If the underlined word or phrase is correct, write "correct" in the corresponding blank space; if incorrect write a word or phrase in the corresponding space which will make the sentence correct.

All living things are built up chiefly of [1]cellulose. Chemical changes going on in plants and animals supply them with [2]energy for all activities of life. All together these changes are spoken of as [3]metamorphosis. All the animals of today are believed to have come from the [4]same kinds of amebas we have today. Because the many animals on the earth today have certain [5]likenesses and differences, scientists have found it possible to divide them into groups. The largest groups in the animal kingdom are called [6]orders. All animals which have a chitinous exoskeleton and jointed feet belong to the same [7]species even though they may be different in many other ways. Animals which are alike except for some minor difference make up a [8]family. Every animal is given a scientific name consisting of two [9]Latin words. The first is a [10]class name and the second a [11]family name.

Since animals like paramecia can be seen only [12]in dense tropical forests, they were not

1 (*protoplasm*)
2 (*correct*)
3 (*metabolism*)
4 (*protozoa of long ago*)
5 (*correct*)
6 (*phyla*)
7 (*phylum*)
8 (*species*)
9 (*correct*)
10 (*genus*)
11 (*species*)
12 (*under a microscope*)

discovered until rather recently. By means of their cilia these animals can [13]kill forest animals for food.

Sponges such as those we use in our household cleaning are important animal products. They are the [14]skeletons of rather simple [15]land animals.

Jellyfishes belong in the phylum [16]Vertebrata because, like all other [17]fishes, they have [18]a backbone. They, like the starfishes, have [19]radial symmetry as adults. Bilateral symmetry first makes its appearance in the animal world in the phylum [20]Platyhelminthes, to which the [21]tapeworms and [22]planaria belong. Earthworms, like the Arthropods, have [23]segmented bodies. Some [24]insects breathe by means of book lungs. Most insects breathe by means of [25]true lungs. Insects are considered to be the most highly developed animals on the [26]vertebrate branch of the animal tree. Echinoderms belong on the chordate branch because the [27]adult forms are very similar to those of some chordates. Among the vertebrates the fishes rank [28]lowest. [29]All fishes have skeletons made of bone. All fishes have [30]fins, [31]breathe by means of gills, and are [32]warm blooded. [33]Turtles, [34]toads, and

13 (*swim*)
14 (*correct*)
15 (*water*)
16 (*Coelenterata*)
17 (*coelenterates*)
18 (*stinging cells*)
19 (*correct*)
20 (*correct*)
21 (*correct*) 22 (*correct*)
23 (*correct*)
24 (*arachnids*)
25 (*spiracles and air tubes*)
26 (*invertebrate*)
27 (*larval forms*)
28 (*correct*) 29 (*some*)
30 (*correct*) 31 (*correct*)
32 (*cold blooded*)
33 (*salamanders, newts*)

[35]frogs are amphibians. Lizards [36]belong in the same group with salamanders because, [37]like them, they have [38]smooth, slimy skin. Birds and bats have wings, have four-chambered hearts, and are [39]warm blooded. All animals that have [40]hair are mammals. Whales are streamlined, live in [41]water, and have only a very few hairs. They are included among the [42]fishes. Monotremes have hair but lay eggs; they are included among the [43]birds. Mammals that live in water breathe by means of lungs and are [44]cold blooded. Mammals are considered the most highly developed of all the [45]vertebrates.

34 (*correct*) 35 (*correct*)
36 (*do not belong*)
37 (*unlike*)
38 (*scaly, dry*)
39 (*correct*)
40 (*correct*)
41 (*correct*)
42 (*mammals*)
43 (*mammals*)
44 (*warm blooded*)
45 (*correct*)

Materials and Equipment

(See page 405)

- Microscope, slides, and cover glasses 4
- Aquarium 4
- Terrarium 4
- Prepared slides of ameba, paramecium, hydra, tapeworm, 4
- Echinoderm skeletons 4
- Mollusk shells 4
- Commercial sponge
- Squid to dissect
- Fish to dissect
- Coral collection 4
- Living material: 4
  - Planaria
  - Earthworms
  - Clam
  - Crayfish
  - *Daphnia*
  - Moth cocoons
  - Fish
  - Amphibians
  - Reptiles
  - Bird
  - Eggs for hatching
  - Hamsters
  - Amebas
  - Hydras
  - *Elodea*
  - *Mimosa*
  - Geranium
- Collection of mounted insects (or pictures) 4
- Pictures of present-day and extinct reptiles
- Colored pictures of birds
- *National Geographic Magazine:* August, 1926; September, 1927; July, 1928; July, 1929; August, 1935; August, 1936; February, 1937; June, 1940; November, 1943
- *Natural History* for Dec., 1942
- *Field Book of Insects,* by Lutz, or "How To Collect and Preserve Insects," American Museum of Natural History
- ANIMALS OF THE SEASHORE
- BIRDS
- FISHES
- INSECT FRIENDS AND ENEMIES
- INSECTS AND THEIR WAYS
- INSECT SOCIETIES
- REPTILES
- SPIDERS
- TOADS AND FROGS

BALANCE IN NATURE

(Note general information page 5)

I. Introduction (pages 3-5)

Core Ideas

The relation of plants and animals to their environment is very complex.

Any change in the environment is likely to bring about a whole series of changes.

The plant and animal populations of a region left to itself tend to remain about the same.

Man is constantly causing trouble for himself by upsetting the balance in nature.

Possible Approach

Read to the class the first three sentences on page 3. Ask the class to suggest reasons for the fact that the farmer's wheat was being ruined by insects. Give them copies of the unitext, and let them check their suggestions by reading the remainder of the first paragraph. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activity

Follow suggestion No. 6 on page 36 of the unitext. (See page 287 of *Everyday Problems in Biology* by Pieper, Beauchamp, and Frank.)

Study Problems and Exercises

1. Make a list of five nonliving factors and five living factors in your own environment.

2. In 1885 a law was passed in Pennsylvania placing a bounty of fifty cents on each hawk and owl. Within a few years so many hawks and owls were killed that crops were being ruined by field

mice and other rodents—the chief food of hawks and owls. The farmers demanded that the law be repealed.

Quote from the unitext a statement which this story illustrates. (*Last sentence on page 3, or third sentence on page 5*)

3. In many cities during recent years campaigns have been carried on to "clean up" parks. Thickets, rotten stumps, and partly dead trees have been removed. In some cases vertical stone walls three or four feet high have been built along banks.

If you were asked to vote money for carrying on such a "clean-up" campaign, how would you vote? (*Against*) Why? (*Such a clean-up campaign upsets the balance in nature by destroying the homes and hiding-places of many animals and keeping animals from getting the water they need.*)

II. THE EARTH'S PLANTS AND ANIMALS (pages 5-9)

Core Ideas

No plant or animal can live in all the many climates to be found in the world.

Altitude and type of soil as well as climate are factors which help determine what plants and animals will be found in any region.

The plants and animals of every region are bound together into a plant-animal community in which the various kinds of living things depend on one another.

The basic problem of all living things is how to get enough food of the right kind.

The question of food supply is more important than any other one thing in tying the living things of a community together.

Possible Approach

Show the class an outline map of the world on which pictures of animals have been drawn or pasted in regions where they could not be found out of captivity. Let the class discuss what is wrong with the picture before reading the section.

Activities

1. Make a diagram or a set of diagrams to show the different plant-animal communities in the sand-dune region described on pages 7 and 8.

2. On a large outline map of the world draw or paste pictures of animals that live in various regions.

Study Problems and Exercises

1. Differences in what factors help to explain most of the differences in the type of forest found in different parts of the world? (*Altitude, rainfall, amount of sunlight, temperature, type of soil*)

2. What is the chief difference between a community of civilized people and a plant-animal community? (*P. 9, ¶¶ 1 and 2*)

3. What is the most important problem for all living things? (*P. 9, ¶ 1*)

III. FOOD-CHAINS (pages 10-14)

Core Ideas

Green plants are the basic group in any plant-animal community.

Animals may be classified, according to the kinds of food they eat, into herbivores, carnivores, and omnivores.

A plant-animal community can be broken up into food-chains.

The plan of most food-chains is: plants-herbivores-small carnivores-large carnivores.

The many overlapping food-chains of a plant-animal community form a food-web.

In general each link in a food-chain is larger than the one before.

Possible Approach

Ask each member of the group to name one animal. Make a list on the board of the animals they name. Discuss the kinds of food these animals eat. On the basis of the kind or kinds of food they eat, ask the class to divide them into three groups. From the text find names for these three groups.

Activities

1. Follow suggestion No. 2 on page 36 of the unitext.
2. Follow suggestion No. 3 on page 36 of the unitext.
3. Follow suggestion No. 5 on page 36 of the unitext.

Study Problems and Exercises

1. On the basis of what you have been told in this section, divide the following animals into three groups: man (O), plant lice (H), spiders (C), hawks (C), wolves (C), giraffes (H), butterflies (H), tigers (C), robins (O), lions (C).

2. Explain why green plants are necessary for all plant and animal life on the earth. (*P.10, ¶1*)

3. Do animals get their energy firsthand from the sun? Explain. (*No—see p.10, ¶5, and p.11, ¶1.*)

4. How do man's food habits differ from those of most animals? (*P.11, ¶3*)

5. What is a food-web? Pick out one food-chain from the food-web on page 19. (One would be: *water plants-tiny water animals-fish-seal-fox.*)

IV. FOOD-PYRAMIDS (pages 14-15)

Core Ideas

The number of individual animals making up the top link in a food-chain is much smaller than the number of individuals making up the lower links.

The total bulk of the animals making up the top link in a food-chain is much less than that of the plants and animals making up the lower links.

If either bulk or number of individuals is considered, every food-chain is really a food-pyramid.

Possible Approach

Call the attention of the class to the food-pyramid on the inside back cover. Let the class try to explain the diagram. Then have them check their explanation by reading the text.

Activity

Change the food-chains pictured on pages 14, 15, 17, and 20 into food-pyramids.

Study Problems and Exercises

1. Explain why the total number of animals and the total bulk (weight) decreases toward the top of a food-chain. (*P.14, ¶3*)

2. "The top carnivore does not lead an easy life." Explain. (*P.15, ¶1*)

V. PARASITE-CHAINS (pages 16-17)

Core Ideas

Parasites are small plants or animals that live on or in the bodies of larger plants and animals.

Being a parasite is not at all an unusual way of living.

There are parasite-chains just as there are ordinary food-chains.

In a parasite-chain each link is larger in number of individuals, smaller in size of individuals, and smaller in total bulk than the link before.

Possible Approach

Call the attention of the class to the pictures on page 22. Discuss these questions: What is meant by calling these three living things "parasites"? How does each one get its food? (*Typhoid germs and malaria germs get their food from the bodies of people; fleas get their food from the bodies of many different kinds of animals.*) Should we consider these parasites less respectable than other plants and animals? Let the class check their answers by reading the first two paragraphs of "Parasite-Chains."

Activities

1. Turn the parasite-chain pictured on page 21 into a pyramid.
2. Examine with a microscope some parasite, perhaps a disease germ of some kind.

Study Problems and Exercises

1. Name the links in the parasite-chain on page 21. (*P.16, ¶ 4*)
2. What two mistaken ideas do many people have about parasites? (*P.16, ¶¶ 2 and 3*)

VI. NICHES (pages 17-21)

Core Ideas

All plant-animal communities are much alike in general organization.

Every member of a plant-animal community has its niche—its role in the community.

Different kinds of plants and animals fill the same niches in different plant-animal communities.

Possible Approach

Call the attention of the class to the two pictures on page 23. Ask for suggestions as to why these two pictures should have been put side by side. Let the class check any suggestions they have by reading the first three paragraphs of "Niches."

Activity

Follow suggestion No. 1 on page 36 of the unitext.

Study Problems and Exercises

1. Explain what is meant by "niche." (*P. 17, ¶ 4*)

2. Why should the three animals pictured on page 26 be pictured together? (*P. 18, ¶ 3*)

3. Tell what niche each of these living things fills: vulture (*P. 17, ¶ 3, picture, p. 24*), plant lice (*P. 18, ¶ 2*), copepods (*P. 18, ¶ 5*), earthworms (*P. 18, ¶ 6*).

VII. RHYTHMS IN PLANT-ANIMAL COMMUNITIES (pages 21-26)

Core Ideas

A plant-animal community varies with day and night and with the seasons.

Seashore communities vary with the rise and fall of the tides.

Through all the changes every plant-animal community stays in balance unless something comes along to upset that balance.

Possible Approach

Read with the class the first paragraph of the section. Let them elaborate the story, if they can, from their own experience.

Activities

1. Make a chart showing the difference between day and night communities in an oak woods. (*P. 21, ¶¶ 3 and 4*)

2. Make another chart showing the difference between day and night communities in a Southwest desert region. (*P. 22, ¶ 3*)

3. From encyclopedias and other reference books make as long a list as you can of animals that hibernate during cold weather.

Study Problems and Exercises

1. Compare in size the day and night communities in the following regions and at the seasons mentioned:

a) Temperate regions in summer (*Day community larger*)

b) Desert of southwestern United States in summer (*Night community larger*)

c) Near the Equator during all seasons (*Night community larger*)

2. Why should the animals pictured on page 27 be grouped together? (*Warm-blooded animals of the arctic*)

3. What rhythm is found among animals living on the edge of the seas? *(P.25, ¶2)*

4. Mark each of the following sentences "True" or "False."

C (1) There is a day and night rhythm among green plants.
X (2) Green plants make sugar during the night and are inactive during the day.
C (3) In most parts of the world changes of season bring about changes in plant-animal communities.
C (4) Some animals do not belong definitely in either the day communities or the night communities.
X (5) Only cold-blooded animals can stand the cold arctic winters.

VIII. How Balance Is Brought About (pages 26-28)

Core Ideas

Balance in nature is brought about partly by changes in the rate of multiplication of the different plants and animals in the community.

Migration of some animals may at times help keep a plant-animal community in balance.

Parasites, starvation, and unfavorable weather are other factors that help to keep plants and animals from increasing too rapidly and upsetting the balance in a plant-animal community.

Plants and animals are kept from increasing in numbers, as a rule, by the plants and animals that prey on them.

Possible Approach

Have the class look again at the food-pyramid on the inside back cover. Ask them to suppose that for some reason the grass for two or three years was much more abundant than usual. What would keep the zebras from increasing so rapidly that they overran the region? Then ask them to suppose that the grass for two or three years was much poorer than usual. What would keep the zebras from decreasing and being all eaten up by the lions? Let the class check their suggestions by reading about a similar food-chain in the first two paragraphs of the section.

Study Problems and Exercises

1. In the case of the acorn-mouse-owl chain pictured on page 14, what keeps the mice from increasing rapidly in numbers and

upsetting the balance in the community? What keeps them from disappearing entirely? (*P. 26, ¶ 2; p. 27, ¶ 1*)

2. List five ways in which the number of top carnivores in a plant-animal community is kept to normal. (*Less rapid multiplication, starvation, parasites, migration, unfavorable weather*)

IX. UNBALANCE IN NATURE (pages 28-31)

Core Ideas

The rates at which living things might increase if there were nothing to check them are astonishingly high.

Sometimes the usual checks do not work, and there are plagues of animals.

Plagues of animals are not fully explained, but they seem to be connected with unusual weather conditions.

Even after a plague, an animal community, if left alone by man, will come back into balance again.

Possible Approach

Reread the story of the Pied Piper of Hamelin. Try to find in this section some fact that may have been the foundation of this story. (*P. 30, ¶ 2*)

Study Problems and Exercises

1. What makes plagues of animals possible? (*P. 29, ¶ 1*)
2. Plagues can often be traced to what? (P. *30, ¶ 3*)
3. In a plague of animals why are these animals not held in check by the carnivores that eat them? (*P. 30, ¶¶ 4 and 5*)

X. UNBALANCE CAUSED BY MAN (pages 31-34)

Core Ideas

Man disturbs the balance in nature in various ways.

Man's disturbance of the balance in nature has had many bad results, some of which have not been evident until long afterward.

Possible Approach

Ask the class to reread the introductory section and to list all the ways mentioned there in which people have upset the balance in nature. Ask them to try to think of other ways in which people can cause unbalance. Perhaps the pictures on pages 32 and 33 will give them one suggestion. Have them check any suggestions they make by glancing through the section.

Activities

1. Follow suggestion No. 4 on page 36 of the unitext.
2. From encyclopedias, other reference books, and ANIMAL TRAVELS, another unitext in this series, find out all that you can about the story of the rabbit in Australia.

Study Problems and Exercises

1. List five different ways in which man has upset the balance in nature. (*Planting large fields of grain or other crops, draining swamps, killing birds and other animals, cutting timber off land, protecting certain animals, bringing new plants or animals into a region, crowding into cities.*)
2. Name four kinds of harm that have come from man's upsetting the balance of nature. (*Floods, increase in number of insect pests, increase in weeds, harm to wild life.*)
3. Why are foreign plants and animals brought into a region likely to become pests? (*P. 34, ¶ 2*)

XI. MAN'S ATTEMPTS TO CONTROL UNBALANCE (pages 34-35)

Core Ideas

Most of man's attempts to control unbalance have been failures, but some have been successful.

The most satisfactory way of controlling a plant or animal which has become a pest is the introduction of a natural enemy of that plant or animal.

Even natural controls should be tried only on the advice of trained scientists, for the enemy introduced might become a pest.

Possible Approach

Ask the class to suppose that the balance in a region was greatly upset by the bringing in of a new kind of animal. Discuss these questions: What might be done to help bring the region back into balance again? What would be the dangers, if any, in using the ways suggested? Let the class check any ideas they express by reading the section.

Activity

Read in INSECTS AND THEIR WAYS, another unitext in this series, or in an encyclopedia, the story of how the ladybird beetle saved the orange groves of California.

Study Problems and Exercises

1. Give an illustration of how man sometimes succeeds in bringing about balance again after he has upset it. (*P. 34, ¶ 4*)

2. Give an illustration of how man sometimes tries but fails to bring about balance again after he has upset it. (*P. 35, ¶ 2*)

XII. Conclusion (pages 35-36)

Core Ideas

People do not put to use all that they know about balance in nature.

If people are willing to follow the advice of scientists, we may yet save the rich natural resources of plant and animal life we have left.

Possible Approach

Have the class look again at the list they made of ways in which man has upset the balance in nature. Discuss which ones of these could rather easily be avoided in the future. Ask the class to find out by reading the first paragraph of the section whether we ought to be satisfied with present conditions.

Activity

Make a poster that will emphasize an important idea of this unit.

Study Problems and Exercises

1. What does the picture on page 35 have to do with balance in nature? (*P. 36, ¶ 1*)

2. Give as clearly as you can in your own words the two main ideas of this section. (*See Core Ideas.*)

Materials and Equipment

(See page 405)

2 outline maps of the world 8
Pictures of animals
Compound microscope 4
A parasite (possibly a disease germ) 4
Story of the Pied Piper of Hamelin
Insects and Their Ways
Animal Travels

COMMUNITY HEALTH

(Note general information page 5)

I. Introduction (pages 3-5)

Core Ideas

To protect the health of its people a community must furnish many different services.

Most of these services are in the hands of health departments.

Work in public health has done much to prolong life.

Every individual in a community has some responsibility for safeguarding the health of the other members of the community.

Possible Approach

Read together the first two paragraphs of the section. Then ask the class to list as many public health services as they know about. Let them check the list they have made with the chart on the inside covers. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activities

1. Follow suggestion No. 3 on page 36 of the unitext.
2. From reference books find out about Walter Reed's work with yellow fever.
3. Get additional information about the work of General Gorgas in Panama.
4. Watch in the newspapers for items about public health.
5. From the health department of your community get a collection of blanks similar to those pictured on page 5 for a bulletin board exhibit.

Study Problems and Exercises

1. List fifteen public health services. Underline those illustrated by the pictures on page 2. (*Underline child hygiene,*

health laboratory, public nursing service, and industrial hygiene.)

2. Quote a sentence from page 3 which tells why public health services are necessary. (*P. 3, ¶ 2, sentence 3 or sentence 7*)

3. What has the chart on page 4 to do with community health? (*P. 4, ¶ 1*)

4. The story of General Gorgas' work in connection with the building of the Panama Canal is told to illustrate what point? (*That with effort the health of a community can be improved, sometimes very markedly.*)

5. Quote a sentence from the book which points out what your own responsibility is in the matter of community hygiene. (*P. 5, last sentence.*)

II. Providing Safe Water (pages 5-6)

Core Ideas

An abundant supply of safe water is necessary for the health of a community.

Various diseases are water-borne.

There are various ways of making impure water safe.

Possible Approach

Call attention to the title of the section. Ask what the term "safe water" means. Check by reading the first two paragraphs of the section.

Activities

1. To find out more about public water supplies, read WATER SUPPLY, another unitext in this series.

2. Find out all that you can about the water supply of your own community.

3. Investigate the health records of your community for the past few years to see whether there have been any epidemics which might have been caused by impure water.

4. Make a small sand filter in a glass funnel or lamp chimney. Find out how successfully it removes the mud from muddy water.

Study Problems and Exercises

1. Mark these sentences true or false:

X (1) One can tell by looking at water whether it is safe to drink.

C (2) Some diseases are carried from person to person in water.

C (3) Typhoid fever is one of the water-borne diseases.

C (4) Harmful chemicals may be present in a water supply.

X (5) If there are as many as a hundred germs in a glass of water, the water is sure to have an unpleasant taste.

2. Name four sources of water supply. Underline the one from which water is obtained for your community.

3. List in a column four methods of purifying water. After each tell what impurity or impurities that method removes.

III. SAFEGUARDING OUR MILK SUPPLY (pages 8-10)

Core Ideas

The quality of a community's milk supply has a great deal to do with the health of the community.

Various diseases may be spread by impure milk.

Health departments have set up standards which all milk sold must meet.

Pasteurization is an important means of insuring the safety of milk supplies.

Possible Approach

Ask in what respects a community's milk supply needs to be safeguarded. Check by reading the first three paragraphs of the section.

Activities

1. Follow suggestion No. 4 on page 36 of the unitext.

2. Follow suggestion No. 5 on page 36 of the unitext.

3. Take milk apart so that you can see what is meant by "milk solids." Activity No. 6 on page 109 of this manual tells you how to do so.

4. From reference books find out how butter, cheese, and ice cream are made and safeguarded.

5. Visit a butter, ice-cream, or cheese-making plant.

6. Find out how milk is tested for butterfat.

7. The National Dairy Council, 111 North Canal Street, Chicago, Illinois, has prepared a great deal of good material concerning milk and milk products. Write to that company asking for a list of their materials and for information as to how you may obtain them.

Study Problems and Exercises

1. Mark these statements true or false:

C (1) Milk can be adulterated easily.
X (2) So far as its food value is concerned, one quart of milk is as good as another.
C (3) Bacteria are responsible for the souring of milk.
X (4) All bacteria are disease germs.
C (5) Typhoid fever may be spread through impure milk.
C (6) Undulant fever may be caused by impure milk.
C (7) Dairy cows may have tuberculosis.
X (8) Dairy cows may have typhoid fever.
X (9) The bacteria which cause milk to sour are germs of Bang's disease.
X (10) Less than 10 per cent of milk is water.

2. The pictures on pages 8, 9, and 10 suggest six questions you would want answered if you were rating the milk from a given dairy company. List these questions. (*Does it come from healthy cows? Are the barns clean and well ventilated? Is the milk kept clean and cold on its trip from the dairy farm? Is the milk carefully tested? Is the milk pasteurized? Is it bottled in a sanitary way?*)

3. Suggest two pictures which might well have been added to the series on pages 8, 9, and 10 in order to give a more complete picture of the steps taken to safeguard a community's milk supply. (*P. 10, ¶¶ 3 and 4*)

IV. FOOD INSPECTION (pages 11-13)

Core Ideas

Health departments also safeguard our supplies of other foods.

The Pure Food and Drugs Administration guards us against food adulteration.

Public eating places as well as food stores are inspected regularly as a means of protecting the health of a community.

Possible Approach

Discuss problems of health connected with supplying food to a community. Glance through the section to find whether the text mentions problems not suggested by the class.

Activities

1. Follow suggestion No. 7 on page 36 of the unitext.

2. From reference books find out what the dangers are in using meat which has not been inspected.

3. From reference books find out more about the chemicals used in protecting fruits and vegetables from insect pests.

4. Talk to operators of restaurants, grocery stores, fruit and vegetable markets, and meat markets in your community to find out how often they are inspected by health officers.

Study Problems and Exercises

1. Fill in the blanks left in this outline.

I. Food inspection is meant to guard us against
    A. (*Disease germs*)
    B. (*Poisonous chemicals*)
    C. (*Food adulteration*)

II. Disinfection of silver and dishes used in public eating places may be brought about by
    A. (*Chlorine*)
    B. (*Steam*)
    C. (*Ultra-violet rays*)

2. Make a list of four questions you would want to have answered if you were inspecting a bakery. (*P. 13, ¶ 2*)

V. GARBAGE DISPOSAL (pages 14-15)

Core Ideas

Garbage, if not properly disposed of, is a menace to health.

Cities have worked out various ways of handling garbage so that it is neither a danger nor a nuisance.

Possible Approach

Discuss the relationship between garbage disposal and community health. Check the ideas advanced by reading the first paragraph of the section.

Activities

1. Follow suggestion No. 6 on page 36 of the unitext.
2. Look up the life-history of the common housefly to better understand the necessity for disposing of garbage properly.

Study Problems and Exercises

1. Make a series of four questions which you could use in rating the garbage disposal plan used in your community.
2. List four ways in which a community may dispose of its garbage after it has been collected.

VI. SEWAGE DISPOSAL (pages 16-17)

Core Ideas

Careless disposal of sewage may lead to epidemics of disease.

Sewage disposal systems solve the problem of keeping sewage from being both a nuisance and a danger.

Possible Approach

Raise the question of the relationship between sewage disposal and health. Let the class try to find backing for their ideas from the text.

Activities

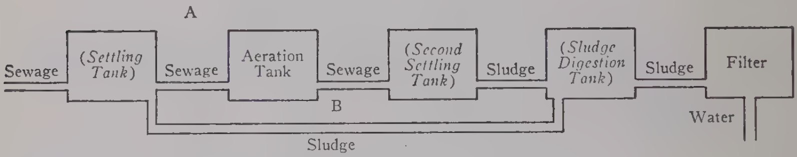
1. To find out more about sewage disposal in general, read pages 29-35 of WATER SUPPLY.
2. Find out about the sewage disposal plan followed in your own community.

Study Problems and Exercises

1. If you were planning a sewer system for a city, could you find out how large the sewers would have to be by finding out how much water all the many households of the city used per hour? Why or why not? (*P. 16, ¶4*)

2. What is the danger to public health of a poor sewage disposal system? (*P. 16, ¶ 3; p. 17, ¶ 3*)

3. This is a simplified diagram of the sewage disposal plan described at the bottom of page 16. Tell what each unlabeled part of the diagram stands for.



What enters at A? (*Activated sludge*)

What enters at B? (*Air*)

VII. Communicable Disease Control (pages 18-23)

Core Ideas

Much of the energy of our health department workers is spent in fighting communicable diseases.

Many communicable diseases are contagious—they are, that is, spread by contact.

Communities fight contagious diseases in various ways, among them quarantine, isolation in hospitals, and immunization.

Animals of various kinds may be disease carriers.

Although communities have done much to lessen the spread of communicable diseases, a great deal of work remains to be done.

Every individual can play an important role in preventing the spread of communicable disease.

Possible Approach

Ask the class to try to define the term "communicable diseases." Check by reading the first paragraph of the section.

Activities

1. Follow suggestion No. 2 on page 36 of the unitext.
2. Follow suggestion No. 11 on page 36 of the unitext.
3. Look at prepared slides of some common disease bacteria.
4. In Keeping Well, another unitext, read "Disease Germs—Threats to Our Health" (pages 28-30) and "Avoiding and Conquering Germs" (pages 31-33).
5. Read also The Fight Against Germs, a unitext in the Basic Social Education Series.
6. Survey your class to find against what diseases they have been immunized.
7. Make a chart showing how many members of your group have had each of the common communicable diseases.
8. Smallpox is a communicable disease which is now almost entirely under control. Find out all that you can about how this control has been brought about.
9. Read the stories of the lives of Jenner, Lister, Koch, and Pasteur.
10. If possible find and read the story of "Typhoid Mary."
11. Watch in newspapers and magazines for news concerning disease epidemics and advances in methods of fighting them.

Study Problems and Exercises

1. In each of these groups of terms there is one which does not belong with the others. Cross it out and give your reason for doing so on the line provided.

1) diphtheria
measles
scarlet fever
whooping cough
~~toothache~~
(Not a contagious disease.)

2) people
flies
rats
~~canaries~~
mosquitoes
(Not disease carriers.)

3) quarantine
~~smoke control~~
use of insecticides
isolation in hospitals
immunization
(Not a way of fighting the spread of contagious diseases.)

2. Explain why a person who is a disease carrier may not be aware that he is endangering others. (*P. 19, ¶ 3*)

3. Mark these sentences true or false:

X (1) Typhoid fever is a common disease of the housefly.
C (2) Ticks carry Rocky Mountain spotted fever.
C (3) Malaria is carried by insects.
X (4) Lice carry malaria.
C (5) Typhus fever may be carried by more than one kind of animal.

4. "John Smith has been ill for several days and his illness has now been diagnosed as rabies. He is supposed to have been exposed to rabies when he went to a movie in a crowded theater." Would you believe this statement if you saw it in a newspaper? Why or why not? (*P. 21, ¶ 2*)

5. What is smallpox vaccine? (*P. 22, ¶ 1*)

6. What is diphtheria toxoid? (*P. 22, ¶ 1*)

7. Tell at least two ways in which you yourself can help prevent the spread of communicable disease.

VIII. TUBERCULOSIS (pages 24-26)

Core Ideas

Tuberculosis is one of the communicable diseases against which a great deal of public health work has been and is being directed.

Much progress has been made in fighting tuberculosis so that it is no longer the dreaded disease it once was.

Possible Approach

Raise the question of whether tuberculosis is a communicable disease. If the class agrees that it is, ask for suggestions as to why a separate section of the book is devoted to it. Check by reading the first paragraph of the section.

Activities

1. Read a fuller account of the life and experiences of Edward Trudeau.

2. Look under a microscope at a prepared slide of tuberculosis bacteria.

3. Follow suggestion No. 12 on page 36 of the unitext.

4. Find out what your own community is doing to fight tuberculosis.

Study Problems and Exercises

1. Why does tuberculosis deserve special attention in a book about community health? (*P. 24, ¶ 1*)

2. Write a brief paragraph telling what we owe to Trudeau.

3. Tell two ways of detecting tuberculosis in its early stages. (*P. 26, ¶¶ 1 and 2*)

4. Make a list of three or more questions you would want to have answered if you were trying to find out whether your community was doing what it should to fight tuberculosis.

IX. CHILD HYGIENE (pages 27-29)

Core Ideas

Increase in average length of life is due in considerable part to the attention given to child hygiene.

The work in child hygiene is carried on through schools, children's clinics, infant welfare centers, and visiting-nurse programs.

Child labor laws have done a great deal to protect the health of children.

Possible Approach

Read together the initial paragraph of the section. Ask for suggestions as to what a community should do for the health of its children. Find out from the text how the list of suggestions compares with the actual steps being taken.

Activities

1. Follow suggestion No. 8 on page 36 of the unitext.

2. Find out what regulations your school enforces to prevent the spread of contagious diseases.

3. Ask your health department how many infant welfare centers, children's clinics, and public nursery schools there are in your community. Find out if you can about how many children these welfare centers, clinics, and nursery schools handle each day.

Study Problems and Exercises

1. List at least six questions you would want answered if you were trying to find out how nearly your community is doing what it should to guard the health of its children. (*Does it have children's clinics? Does it have infant welfare stations? Do its schools have doctors and nurses? Do its schools teach health? Are there schools for handicapped children? Do visiting nurses visit homes when there are newborn babies?*)

2. Suppose of ten babies born five died when only one year old and the others lived to be fifty years old. What would their average length of life be? (*25½*)

Suppose only one of the ten died when it was a year old and the other nine lived to be fifty. What would their average length of life be? (*45 1/10*)

These figures help you understand what chart in the book? (*The one on p. 4.*)

3. Tell one problem our country has still to solve in connection with child labor laws. (*P. 29, ¶ 2*)

X. Industrial Hygiene (pages 30-31)

Core Ideas

There are many laws designed to protect the health of industrial workers.

Other laws protect the health of people living near industrial plants.

Possible Approach

Ask the class to suggest problems of industrial hygiene with which health departments should concern themselves. Find by glancing through the section whether there are other types of problems not suggested by the class.

Activities

1. If there are factories in your community, find out as much as you can about their health regulations.

2. Write to the health department of your state for pamphlets dealing with industrial hygiene.

Study Problems and Exercises

1. Mark these sentences true or false:

X (1) Workmen run into the same health hazards in all industries.

X (2) Measures taken to improve the health of workers in industry benefit only the workers themselves.

C (3) Too many hours of work make for a high accident rate.

C (4) By becoming overtired a worker makes himself more susceptible to disease.

C (5) Industrial plants may endanger the health of people living near by.

2. The workmen in the picture on page 31 are being protected against what danger? The workman in the lower right-hand picture on page 2? (*P. 30, ¶ 4*)

XI. HOUSING (pages 32-33)

Core Ideas

Poor housing favors the spread of disease.

Slum clearance and new housing projects are bettering housing conditions in some of our cities.

Health departments help in various ways to better housing conditions.

Possible Approach

Raise the question of what housing has to do with health. Check the suggestions offered by reading the first paragraph of this section.

Activities

1. Follow suggestion No. 9 on page 36 of the unitext.

2. Make a survey of the public playgrounds in your community. Find out how they are supported.

3. Find out all that you can about the building code of your community.

Study Problems and Exercises

1. Suppose there is a slum area in your city. What arguments could you present to your city government to convince them that this area is a menace to the whole city? (*P. 32, ¶ 1*)

2. List four questions you would ask in deciding whether a given building was a fit place, from the standpoint of health, for people to live in.

XII. THE WORK OF HEALTH LABORATORIES (page 34)

Core Ideas

Laboratories do much toward advancing public health.

Along with other kinds of work state laboratories help in the diagnosis of disease and in the preparation of vaccines and other such materials for the prevention and treatment of disease.

State and city laboratories test samples of such things as water and milk sent in by inspectors.

Possible Approach

Ask the class to pick out from the photographs in the book those which they think are included to illustrate the work of health laboratories. Check by reading the first paragraph of the section.

Activities

1. If your community has a health laboratory, visit it.
2. Find out from your doctor for what help he depends on the laboratory maintained by the state board of health.

Study Problems and Exercises

1. Name four kinds of work which health laboratories carry on. (*Study disease, help diagnose diseases, prepare serums, test milk, etc.*)
2. What do the pictures on pages 34 and 35 have to do with the work of health laboratories? (*P. 34, ¶ 1*)

XIII. EDUCATING THE PUBLIC (page 35)

Core Ideas

Health departments try in various ways to teach people rules of personal and community hygiene.

Health departments also try to make people see the importance of following the rules they have been taught.

Possible Approach

Discuss what is being done in your school toward teaching the students rules of community hygiene. Raise the question as to whether work in schools is enough. Let the class try to find backing for their ideas in the text.

Activities

1. Follow suggestion No. 10 on page 36 of the unitext.
2. Make a survey of what is being done in the various grades of your school toward teaching the students the rules of personal and community hygiene and making them see the importance of following those rules.
3. If you see a number of students carelessly breaking health rules, organize as a group a campaign to bring about some improvement.

Study Problems and Exercises

1. In trying to educate the public, health departments are working along two lines. What are they? (*Teaching people good rules of community hygiene. Bringing about a willingness to follow them.*)
2. List three precautions which everyone should be taught to take. (*P. 35, ¶ 2*)

Materials and Equipment

(See page 405)

Microscope 4
Prepared slides of common disease bacteria 4
Prepared slides of tuberculosis bacteria 4
Glass funnel or chimney 4
Sand
Milk 2
Lactic acid 4
Rennet 4
Fight Against Germs
Keeping Well
Water Supply

DOMESTICATED ANIMALS

(Note general information page 5)

I. INTRODUCTION (pages 3-4)

Core Ideas

The domestication of plants and animals made it possible for early man to give up a nomadic existence.

Domesticated animals came to serve many purposes.

Man has domesticated many different animals, most of them either mammals or birds.

Our common domesticated animals, all of which were domesticated long ago, serve our purposes so well that little attempt is being made to domesticate animals that still exist only in the wild.

Possible Approach

Write on the board this or some similar sentence: "In man's long climb from savagery to civilization one of the most important steps was the domestication of plants and animals." Lead the class to give any reasons they can for agreeing or disagreeing with the statement. Check their ideas by reading the first four paragraphs of the section. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activities

1. Follow suggestion No. 1 on page 36 of the unitext.
2. Assemble a collection of pictures of the less well known domesticated and semidomesticated animals.
3. Write a story or article comparing the way our early caveman ancestors got their food with the way we get ours.

4. Read about the camel in "The Camel, Man's Age-old Servant," in the September, 1942, issue of the *National Geographic Magazine.*

Study Problems and Exercises

1. Mark the following statements true or false. After each one copy the first two words of a sentence in the text which backs up your judgment.

C (1) The domestication of plants and animals made it possible for man to give up a nomadic existence. (*No longer*)
X (2) All our domesticated animals are either mammals or birds. (*Goldfish and*)
X (3) Many attempts are now being made to domesticate wild animals of kinds that have never been tamed. (*But those*)
C (4) Domesticated animals serve many purposes. (*But the*)
X (5) The cat is believed to have been the first animal to be domesticated. (*The order*)

2. Using some basis mentioned in the text group these domesticated animals into two groups. Give each group a title.

yak
dog
alpaca
horse
parakeet
goat
falcon
reindeer
turkey
peacock
goose
camel

(*Mammals: yak, dog, alpaca, horse, goat, reindeer, camel.*
Birds: parakeet, falcon, turkey, peacock, goose.)

II. GREAT CHANGES (page 5)

Core Ideas

Great changes took place in animals before any animals were tamed.

Man has brought about changes in the animals he domesticated.

The changes brought about in domesticated animals have made them serve our purposes more satisfactorily.

Possible Approach

Call attention to the picture at the top of page 5. Ask for suggestions as to why *Eohippus* and the Asiatic wild horse should be pictured together. Check any suggestions offered by reading the first two paragraphs of the section.

Activities

1. Follow suggestion No. 2 on page 36 of the unitext.
2. In ANIMALS OF YESTERDAY, another unitext, read the story of the evolution of the elephant.
3. Study the exhibits on the evolution of the horse at a natural history museum.

Study Problem

What are the three important ideas presented on page 5? (*See Core Ideas listed above.*)

III. ORIGIN OF OUR DOMESTICATED ANIMALS (pages 6-10)

Core Ideas

The question of the origin of our domesticated animals is made up of two questions: What wild animals were the ancestors of our domesticated animals? In what regions were they first domesticated?

Many of our common domesticated animals were domesticated so long ago that there is considerable doubt concerning their origin.

Possible Approach

Call attention to the title of the section. Ask what it means to the class. Check by reading the first paragraph of the section.

Activities

1. Read more about the origin of some of our common domesticated animals in *Our Friendly Animals and Whence They Came,* by Karl Schmidt.
2. Read "The Domestication of Animals" in the May, 1945, issue of *Natural History.*

Study Problems and Exercises

1. "The chicken came originally from India." Does this

statement answer fully the question of the origin of the chicken? Why or why not? (*P. 6, ¶ 1*)

2. What conclusion can you draw from the map on the inside covers? (*Practically all our domesticated animals originated in the Old World.*)

3. Fill in this chart, naming any ten domesticated animals you please.

Domesticated Animal	Probable Ancestor	Region Where Domesticated
1)		

IV. ANIMAL BREEDS (pages 11-18)

Core Ideas

Man has developed many breeds of all the more common domesticated animals.

In modern times a standard of perfection has been set for each breed.

Animal breeding has proceeded in some cases along such divergent lines that one breed of animal may differ more from another breed of the same kind of animal than it differs from its wild ancestor.

Possible Approach

Read the first two paragraphs of the section together. Then let the class tell, before reading further, what they already know about the various breeds of our common domesticated animals.

Activities

1. Follow suggestion No. 3 on page 36 of the unitext.
2. Follow suggestion No. 4 on page 36 of the unitext.
3. Follow suggestion No. 5 on page 36 of the unitext.
4. Follow suggestion No. 13 on page 36 of the unitext.
5. Get the standards of perfection by which some breed of animal is judged.
6. The Department of Agriculture has many inexpensive bulletins about domesticated animals. Get a catalogue and order those which particularly interest you.

7. Find out what the record milk yield is for a dairy cow and for a dairy herd.

8. Read more about dogs in the following numbers of the *National Geographic Magazine*: February, 1936 (terriers), October, 1937 (hounds), December, 1941 (working dogs), November, 1943 (non-sporting dogs), April, 1944 (toy dogs), September, 1944 (working dogs), and September, 1947 (bird dogs).

Study Problems and Exercises

1. Sort out these breeds into groups and give each group an appropriate title:

Bronze
Shetland
Karakul
Siamese
Duroc-Jersey
Clydesdale
Holstein
Whippet
Merino
Percheron
Poland China
Minorca
Shorthorn
Doberman
Chester White
Guernsey
Tamworth
Dachshund
Thoroughbred
Fantail
Muscovy
Hereford
Oriental Frill
Hackney
Manx
Jersey
Rouen
Himalayan
Narragansett
Shropshire
Persian
Plymouth Rock

2. Give five examples of the fact that development of some domesticated animals has proceeded along two or more different lines. (*Sheep for wool and for meat; cattle for milk and for meat; horses for strength and for speed; hogs for bacon and for lard; chickens for eggs and for meat; dogs for hunting, for racing, for working, and for pets, etc.*)

3. Fill in each blank with a good example.

1) A working dog ________________
2) A milk goat ________________
3) A dairy cow ________________
4) A sheep valued chiefly for its wool ________________
5) A draft horse ________________
6) A tailless cat ________________
7) A large domestic duck ________________
8) A red hog of the lard type ________________
9) A sporting dog ________________
10) A pigeon used for carrying messages ________________

4. The steer that won the championship in the 1948 Livestock Exposition in Chicago was an Aberdeen Angus. Does this fact mean that Aberdeen Angus is the best breed of beef cattle? If not, what does it mean? (*It means that the steer that won the championship came nearest to meeting the standards of perfection set for its breed.*)

V. ANIMAL REPRODUCTION (pages 19-24)

Core Ideas

The development and improvement of breeds of animals is based on the facts that "like begets like" and that no two animals are ever exactly alike.

Variations among animals may be due to either environment or heredity.

Changes brought about by the environment cannot, except in rare instances, be inherited.

All our domesticated animals reproduce by sexual reproduction.

Body cells multiply by mitosis.

Reproductive cells are formed by meiosis.

Genes are the bearers of hereditary characteristics.

Offspring resemble their parents because they inherit their genes from them.

Possible Approach

Read together the first five paragraphs of the section. Then examine a number of pictures of animals with their young to get evidence for the two somewhat contradictory statements mentioned in the first paragraph.

Activities

1. Follow suggestion No. 6 on page 36 of the unitext.
2. Follow suggestion No. 7 on page 36 of the unitext.
3. Follow suggestion No. 8 on page 36 of the unitext.
4. Follow suggestion No. 9 on page 36 of the unitext.
5. Follow suggestion No. 10 on page 36 of the unitext.
6. With a clean knife scrape the inside of your cheek. Some mucus containing a few of the epithelial, or lining, cells of your cheek will come off on the knife. Place them on a microscope slide. Add a drop of methylene blue solution to stain the cells.

Observe under the microscope. Identify as many parts of the cells as you can.

7. Carry on experiments with rats to show variation due to outside conditions. Determine the effect of different diets or of different amounts of light on the animals' development. If possible, determine whether or not these effects are hereditary by mating affected animals.

8. Examine various kinds of animals. Note and make a record of variations you observe. Insects, mice, rats, guinea pigs, hamsters, and frogs are some you can observe.

9. Raise guppies or some other live-bearing fish.

10. Get some frog eggs in the early spring. Put them in an aquarium and watch them develop.

11. Find out how incubation and gestation periods differ for different domesticated birds and mammals.

Study Problems and Exercises

1. Mark the following statements true or false. After each copy the first two words of a sentence from the text which backs up your judgment.

C	(1)	No two living things are exactly alike.	(*The other*)
C	(2)	Like begets like.	(*One is*)
C	(3)	Differences in environment cause some variations.	(*Some variations*)
C	(4)	Some variations can be inherited.	(*But some*)
X	(5)	All variations can be inherited.	(*Animals do*)

2. Copy the diagram of the animal cells on page 21, labeling the nucleus, cytoplasm and cell wall.

3. Match these terms and definitions by writing the number of each definition after the term it defines.

Gametes (*5*)
Zygote (*6*)
Sperm (*7*)
Egg (*2*)
Chromosomes (*10*)
Nucleus (*4*)

(1) Living material
(2) Female sex cell
(3) Process by means of which body cells divide.
(4) A small body of dense protoplasm within each cell.
(5) Reproductive cells
(6) Fertilized egg

Gene (*12*)
Mitosis (*3*)
Meiosis (*8*)
Protoplasm (*1*)
Sexual reproduction (*11*)
Asexual reproduction (*9*)

(7) Male sex cell
(8) Process by means of which reproductive cells divide.
(9) Reproduction involving no union of reproductive cells
(10) Bodies found within the nucleus of a cell.
(11) Reproduction involving the union of two reproductive cells.
(12) Bearer of a hereditary characteristic

4. What was the picture of the ameba on page 21 put in to illustrate? (*Asexual reproduction*)

5. Redraw the mitosis diagram on page 22, starting with eight chromosomes instead of six.

6. Redraw the meiosis diagram on page 23, starting with eight chromosomes instead of six.

7. "The story of fertilization and of the development of the young after fertilization is practically the same for all our domesticated mammals and birds." Criticize this statement. (*P. 24, ¶ 4*)

VI. How Variations Come About (pages 25-31)

Core Ideas

There are definite laws governing heredity.

Some variation is due to mixed ancestry; hybrids do not breed true.

The basic sources of variations are mutations—changes in chromosomes or genes.

Animals showing marked and abrupt changes are called sports, or mutants.

Most mutations are bad, but enough good ones occur to help man greatly in improving his domesticated animals.

Possible Approach

Ask the class to suppose for a moment that no variations can be passed on to the next generation. Raise the question of what that would mean so far as our domesticated animals are concerned. Check by reading the first paragraph of the section.

Activities

1. Follow suggestion No. 11 on page 36 of the unitext.
2. Follow suggestion No. 12 on page 36 of the unitext.
3. Illustrate the operation of the laws of chance as they occur in heredity. Obtain 200 marbles, beans, or similar objects of two different colors—100 of each. Let one color represent a dominant characteristic and one color a recessive characteristic (the opposite of a dominant characteristic). Put them in a container and mix them up. Get three other containers and label them "dominant," "hybrid," and "recessive." Close your eyes and draw out a marble with each hand. If they are both "dominant" put them in the container marked "dominant." If they are both "recessive," put them in the container marked "recessive." If you draw out one of each color put them in the "hybrid" container. When you have drawn out all 200 marbles, find the ratio of the marbles in each jar. How does this compare with Mendel's ratio? Let everyone in the class try the experiment, and add up the results. Is the ratio now nearer the 1:2:1 ratio?
4. Cut out 9 circles about half an inch in diameter from each of the following colors of paper: white, black, red, blue. Let each white circle stand for a gene for white, each black circle for a gene for black, each red circle for a gene for rough coat, and each blue circle for a gene for smooth coat. Paste these circles on a large sheet of white paper to show the nine different combinations of genes possible when two hybrid guinea pigs like those in the chart on page 27 are mated.
5. Get 400 paper clips all of the same size. To 100 tie short white threads, to 100 short black threads, to 100 short red threads, and to 100 short blue threads. As in Activity 4, black and white stand for genes for color of coat, red stands for rough coat, and blue for smooth coat. Put all those with black and white threads in one container and all those with red and blue threads in another. Divide a paper into four columns headed "black rough," "black smooth," "white rough," and "white smooth."

Now put one hand in one container and one in the other and draw out two paper clips with each. Decide, knowing that black and rough are dominant, how a guinea pig with those genes would look. Make a tally in the proper column. Continue until you have drawn out all the clips. How nearly is the ratio the 9:3:3:1 ratio shown in the diagram on page *27*?

Let everyone in the class try the experiment, and add the results. Is the ratio any more nearly 9:3:3:1?

6. Find out how to carry on heredity experiments with fruit flies. General Biological Supply, Chicago, Illinois, has a pamphlet on this subject.

7. In reference books look up material for special reports on the lives of Mendel, de Vries, Lamarck, and Darwin, all scientists interested in the study of heredity.

8. From current magazine articles find out what you can about mutations brought about by atomic radiation.

Study Problems and Exercises

1. Make a suitable title for the illustration on page 25. (*Examples of Hereditary Variation*)

2. What chart in the book illustrates Mendel's law of unit characters? (*P. 27*)

3. What chart illustrates Mendel's law of segregation? (*P. 28*)

4. What two charts illustrate Mendel's law of dominance? (*P. 27 and p. 29*)

5. Why is the chart on page 27 so much more complicated than the chart on page 29? (*P. 29, ¶ 2*)

6. Answer the following questions about the chart on page 27:

Which guinea pigs are pure black?	(*1b, 2a, 1a, 2b*)
Which guinea pigs are pure white?	(*3d, 4c, 3c, 4d*)
Which guinea pigs are pure smooth?	(*2d, 4b, 2b, 4d*)
Which guinea pigs are pure rough?	(*1c, 3a, 1a, 3c*)
Which guinea pigs are pure for both characteristics?	(*1a, 2b, 3c, 4d*)

VII. Using the Principles of Genetics (page 32)

Core Ideas

The science which deals with heredity is called genetics.

Animal breeders developed and improved breeds through selection and hybridization before there was a science of genetics.

Genetics enables the animal breeder to carry on his work of selection and hybridization in a more scientific way.

Scientific studies of the proper food and care also deserve credit for the high standards reached by many of our domesticated animals of today.

Possible Approach

Call attention to the third paragraph on page 15 and to the third paragraph on page 25. Ask the class to find a statement on page 32 which these two paragraphs back up. (¶ *1, sentence 2*)

Activities

1. From an almanac find out what the speed records for various kinds of race horses—runners, trotters, and pacers—are.
2. From current magazines find out what is being done in the fur industry with animal breeding.
3. Choose some breed of domesticated animal and find out what the best diet for that kind of animal is supposed to be.

Study Problems and Exercises

1. What are pedigrees? (*P. 32,* ¶ *2*)
2. What would the pedigree of guinea pig *1d* in the chart on page 27 tell you that you could not tell by looking at the guinea pig? (*It has a white and a smooth ancestor and might be able to pass on both whiteness and smoothness to its descendants.*)
3. By what two methods did animal breeders improve domesticated animals before there was a science of genetics? (*P. 32,* ¶ *1*)
4. "All the modern work toward improving our domesticated animals is based on the work of Mendel." Do you agree or disagree? Explain. (*P. 32,* ¶ *6*)

VIII. Hybrids (pages 33-35)

Core Ideas

Some crosses have been made between different species of animals.

Hybrids of this kind are usually sterile.

The mule is the most useful hybrid, but various cattle hybrids are promising.

Possible Approach

Call attention to the picture on page 33. Ask why it belongs in a section on hybrids. Check by reading the first three paragraphs of the section.

Activities

1. Watch in newspapers and magazines for items concerning the development of cattle hybrids.
2. Find in information almanacs how the number of mules compares with the number of horses in each of the states. What conclusions can you draw from the figures?

Study Problems and Exercises

1. The mule shown on page 33 and the roan cattle shown on page 28 are hybrids, but they are hybrids in a different sense. Explain. *(P. 33, ¶ 1)*
2. Name one fact which limits the development of hybrids. *(P. 33, ¶ 2)*
3. List the hybrids pictured and tell in the case of each one what animals were crossed to produce it and what advantages, in case the text tells, it is supposed to have. *(P. 33, ¶ 3; p. 34, ¶ 1; p. 34, ¶¶ 2 and 3; p. 35, ¶ 1)*

Materials and Equipment

(See page 405)

Microscope, slides, and cover glasses 4
Incubator 4
Prepared slides of mitosis 4
Aquarium 4
Living amebas 4
Fertile eggs
Guppies or other live-bearing fish
Guinea pigs or rats for breeding
Frog eggs
Methylene blue solution 4
Modeling clay 5
Marbles or beans, 100 each of two different colors
Paper clips
Paper: white, black, red, and blue 5
Thread: black, white, red, and blue
Our Friendly Animals and Whence They Came, by Karl Schmidt
Natural History for February, 1939, and May, 1945
National Geographic for February, 1936, October, 1937, December, 1941, November, 1943, April, 1944, September, 1944, and September, 1947
ANIMALS OF YESTERDAY
DOMESTICATED PLANTS
LIFE THROUGH THE AGES

DOMESTICATED PLANTS

(Note general information page 5)

I. INTRODUCTION (pages 3-5)

Core Ideas

The domestication of plants made it possible for people to give up a nomadic existence and have permanent homes.

All our domesticated plants are descendants of plants that once grew wild.

Many of our domesticated plants differ greatly from their wild ancestors.

We ourselves have brought about many of the changes in our domesticated plants.

Some of our new kinds and varieties of plants have been made to order to suit our purposes.

Many of our new kinds and varieties of plants are hybrids—crosses between plants that differ markedly in at least one characteristic.

Possible Approach

Ask the class to give their ideas as to why the domestication of plants is considered a very important step in human progress. Check by reading the first two paragraphs of the section. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activities

1. Follow suggestion No. 1 on page 36 of the unitext.
2. Follow suggestion No. 2 on page 36 of the unitext.
3. Follow suggestion No. 3 on page 36 of the unitext.

4. Follow suggestion No. 4 on page 36 of the unitext.

5. Follow suggestion No. 5 on page 36 of the unitext.

6. Write a story telling how the first domestication of plants might have taken place.

Study Problems and Exercises

1. What are the illustrations on pages 2 and 3 meant to show? (*P. 4, ¶ 1*)

2. What is the illustration on page 4 meant to show? (*P. 4, ¶ 2*)

3. Mark these sentences true or false:

C (1) At one time man used only wild plants and animals as food.
X (2) Plants were domesticated long before animals were.
C (3) All the plants we raise today are descendants of plants that once grew wild.
C (4) Broccoli is a descendant of wild cabbage.
X (5) The domestication of plants has made them much better fitted for their surroundings.
C (6) The large plum pictured on page 6 has been patented by our government.
X (7) Every hybrid plant has only one parent.
X (8) Man has learned how to produce hybrid roses only within the last twenty-five years.
X (9) All our domesticated plants are food plants.
X (10) Wild cauliflower is a common wild flower in the fields and meadows of Europe.

4. What is the usual first step in a plant breeder's attempt to produce a desirable new variety of some cultivated plant? (*P. 5, ¶ 1*)

5. Make a suitable title for the picture on page 5. (*P. 5, ¶ 2*)

II. Hybrid Roses (pages 7-9)

Core Ideas

The four sets of parts in a rose flower are the sepals, petals, stamens, and pistils.

Before a rose seed can be produced, a sperm in a pollen grain from a stamen must unite with the egg in an ovule in a pistil.

In hybridization the pollen comes from the stamens of one variety of rose while the ovules are in the pistils of another variety.

A desirable rose hybrid can be multiplied by means of cutting.

Possible Approach

Explain that every new kind of hybrid rose comes from a seed. Let the class tell what they know of how such a seed is produced. Check by reading the first three paragraphs of the section.

Activities

1. Follow suggestion No. 6 on page 36 of the unitext.
2. From nursery catalogues make a collection of pictures of hybrid roses.

Study Problems and Exercises

1. Give the correct name for each of the following:

(*Stamens*)	The male parts of a flower.
(*Pistils*)	The female parts of a flower.
(*Anther*)	The part of a stamen which produces pollen grains.
(*Ovary*)	The part of a pistil which produces ovules.
(*Ovule*)	The structure which produces the egg.
(*Stigma*)	The part of the pistil which the pollen grains much reach if fertilization is to take place.
(*Pollen grain*)	The structure which contains the sperms.
(*Sperm*)	The cell which fertilizes the egg.
(*Embryo*)	The structure which develops from the fertilized egg.
(*Ovule*)	The structure which develops into the seed.

2. Make a suitable title for the pictures on page 8. (*P. 8, ¶ 2*)

3. You wish to cross a yellow rose with a white one. You choose the yellow rose as the male parent and the white rose as the female parent. Continue the story. (*P. 8, ¶ 4*)

4. Suppose you produce a desirable hybrid by crossing the yellow and white roses. How do you go about raising more just like it? (*P. 9, ¶ 3*)

III. HYBRID CORN (pages 10-12)

Core Ideas

Corn can be raised only from seeds.

Since hybrids do not breed true, the crossing which results in the hybrid corn seed must be done anew for each year's planting.

Most of our varieties of hybrid corn are double-crosses.

The production of hybrid corn seed is a complicated process.

Possible Approach

Reread together the last paragraph on page 6. Ask the class what they know about how corn is raised. Do they know of any way in which raising hybrid corn would differ from raising hybrid roses? Check by reading the first paragraph on page 10.

Activities

1. Follow suggestion No. 7 on page 36 of the unitext.

2. Find out about prices of hybrid seed as compared with prices of other seed corn. Find out, too, about average hybrid corn yields as compared with other field corn yields.

3. If you live in a region where corn is an important crop, watch for signs, as you ride through the country, that much of the corn being raised is hybrid corn. Many dealers in hybrid corn seed furnish placards to be put on the fences surrounding the cornfields telling what hybrid is being raised.

Study Problems and Exercises

1. What two facts make it necessary to hybridize corn anew for each season's planting? (*P. 10, ¶ 1*)

2. Why is self-pollination more easily prevented in corn than in roses? (*P. 10, ¶ 2*)

3. What are the tassels of the corn plant? (*P. 10, ¶ 2*)

4. Through what must the sperm travel to reach the egg? (*P. 10, ¶ 2*)

5. By what means does the pollen reach the silks? (*P. 11, ¶ 1*)

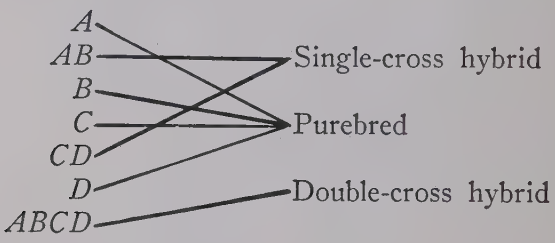
6. Make a suitable title for the picture on page 10. (*Detasseling Corn*)

7. Make a suitable title for the chart on page 12. (*Steps in Producing Double-Cross Hybrid Corn Seed*)

8. Mark these statements true or false:

X (1) The girl in the inset picture on page 10 is removing the female flowers from a stalk of corn.
X (2) The silks on a corn stalk produce pollen.
X (3) An ovule is located at the base of each tassel.
C (4) The stamens are located on the tassels.
C (5) In a field like the one pictured on page 10 the detasseled plants are sure to produce hybrid seed.
X (6) Self-pollination cannot occur unless the corn plant has been detasseled.
X (7) Inbreeding is the best way to get good yields of corn.
X (8) Hybrid plants breed true.
X (9) In a field like the one pictured on page 10 all the rows come from the same kind of seed.
X (10) The production of hybrid seed is so simple that most farmers produce it for themselves.

9. All the ears of corn in the diagram on page 12 are marked by letters. Match each of the seven ears listed in the first column below with one of the descriptions in the second column.



IV. PLANT REPRODUCTION (pages 13-16)

Core Ideas

Most of our domesticated plants are flowering plants.

Pollination and fertilization are important steps in seed production.

Some flowers are normally self-pollinated, others cross-pollinated.

Flowers that must be cross-pollinated have many different devices for insuring cross-pollination.

Many of our domesticated plants can also reproduce vegetatively.

It is important in perpetuating valuable new varieties of plants that many can reproduce vegetatively.

Bulbs, corms, cuttings, rhizomes, roots, tubers, runners, leaves, and fruits are means of vegetative reproduction.

Grafting helps in the perpetuation of many new and desirable varieties of plants.

Possible Approach

Call attention to the illustration at the top of page 13. Ask the class to interpret it. Check the interpretation by reading the first two paragraphs of the section.

Activities

1. Follow suggestion No. 8 on page 36 of the unitext.
2. Follow suggestion No. 9 on page 36 of the unitext.
3. Examine the flowers of a number of our cultivated plants. Make a chart telling the number of sepals, petals, stamens, and pistils found in each.
4. Find out what the terms "annuals," "biennials," and "perennials" mean.
5. Plan and set up an exhibit showing ways in which plants reproduce.
6. Make a collection of seeds of common cultivated plants. Plant a few of each in pots in the classroom and watch them germinate.

Study Problems and Exercises

1. List the following flower parts and tell after each what purpose they serve: sepals, petals, pistils, stamens, ovules, pollen. (*P. 7, ¶ 1; p. 13, ¶¶ 3-4*)
2. List five adaptations which plants have for bringing about cross-pollination. (*P. 14, ¶¶ 1-2*)
3. Make a suitable title for all six of the pictures on pages 14 and 15. (*Six Means of Vegetative Reproduction*)
4. Name four other pictures which might well have been added to the group on pages 14 and 15. (*P. 15, ¶ 4*)

5. Identify each of the following:

(*Bulb*)	An underground stem wrapped in fleshy leaves.
(*Corm*)	A fleshy underground stem surrounded by only a few leaves.
(*Buds*)	The "eyes" of a potato.
(*Rhizomes*)	Horizontal stems that grow underground.
(*Tuber*)	A very fleshy underground stem with "eyes."
(*Runners*)	Horizontal stems above ground which send roots into the ground and leaves into the air.

6. Suppose you developed an excellent hybrid potato. How would you get more like it? (*P. 15, ¶ 4*)

7. What two conditions must be met to make grafting successful? (*P. 16, ¶ 1*)

8. Reread the last paragraph on page 9. Which of the plans mentioned would you use if you were in a hurry for the new hybrid plants to bloom quickly? (*P. 16, ¶ 2*)

V. Bringing about Changes (pages 17-24)

Core Ideas

Hybridization has produced many new kinds and varieties of plants.

The greatest disadvantage in hybridization is that hybrids do not breed true.

Only closely related plants can be crossed.

Mutants are sports, plants which appear suddenly and differ markedly in at least one characteristic from their ancestors.

Mutants breed true.

No one yet knows how to bring about desirable mutations.

Mutations may occur on only part of a plant, in which case they may be called bud variants.

We have gradually developed new varieties of plants by selection.

We have brought about many desirable changes in our domesticated plants by improving environmental conditions.

We have been able to make plants grow in such a way as to suit our purposes better through the use of chemicals called growth regulators.

Possible Approach

Point out that the class now knows one way of producing new kinds of plants—hybridization. Let them suggest hybrids not yet produced which they think would be valuable. Ask for suggestions as to why these hybrids have not been produced. Check by reading the first two paragraphs of the section.

Activities

1. Follow suggestion No. 10 on page 36 of the unitext.
2. Follow suggestion No. 11 on page 36 of the unitext.
3. Follow suggestion No. 12 on page 36 of the unitext.
4. Follow suggestion No. 13 on page 36 of the unitext.
5. Examine a navel orange and an orange containing seeds, and compare the two.
6. Try some experiments with rooting foliage plants, using growth regulators in some cases and not in others.
7. There are hundreds of varieties of narcissi, commonly called daffodils. They are divided by growers into a number of divisions. From bulb catalogues find representatives of the various divisions.
8. Raise a number of seedlings of some plant which can be grown easily in your classroom. Show by providing different conditions of light, moisture, and temperature for the various seedlings that environmental conditions are very important in producing plants which meet our modern standards.

Study Problems and Exercises

1. Would you be successful if you tried to cross a carrot with a potato to produce a hybrid? Why or why not? *(P. 17, ¶ 2)*
2. Tell one reason why vegetative means of reproduction are important to plant growers. *(P. 18, ¶ 1)*
3. If you developed a new hybrid corn plant, would you be given a patent on it? Why or why not? *(P. 18, ¶ 1)*
4. What advantage do desirable mutants have over desirable hybrids? *(P. 18, ¶ 3)*
5. By what two artificial means have scientists brought about mutations? *(P. 19, ¶ 1)*

6. In the list below place an *M* in front of each of the mutants and an *H* in front of each of the hybrids.

bush lima bean (*M*)
tangelo (*H*)
loganberry (*M*)
Concord grape (*M*)
double nasturtium (*M*)
red sunflower (*M*)
Harison's yellow rose (*H*)
rutabaga (*M*)
plumcot (*H*)
nectarine (*M*)
navel orange (*M*)
citrange (*H*)

7. Make a suitable title for both pictures on page 22. (*P. 20, ¶¶ 3 and 4*)

8. Since mutants breed true, why can't navel orange trees be raised from seeds? (*P. 20, ¶ 4*)

9. What is meant by selection in plant breeding? (*P. 22, ¶ 1*)

10. State in one sentence the most important idea in the second paragraph on page 22.

11. List five ways in which growth regulators can bring about improvements in plants. (*P. 22, ¶ 4; p. 23, ¶¶ 2, 3, 4; p. 24, ¶ 3*)

12. Make a suitable title for the picture on page 25. (*P. 22, ¶ 4*)

VI. The Science behind the Changes (pages 25-31)

Core Ideas

Studies of plant growth have helped us make the most of the varieties of plants we have.

Growth regulators are similar to the plant hormones which plants make for themselves.

There are definite laws governing heredity.

Chromosomes are the bearers of heredity, and genes are the determiners of specific characteristics.

Understanding about chromosomes and genes helps us understand why hybrids do not breed true, what mutations are, and why selection has been a successful method of improving our domesticated plants.

Possible Approach

Ask the class to recall the five ways in which man has brought about changes in his cultivated plants. Point out that knowing methods of bringing about changes is quite different from knowing how and why the methods work, and that the section dealing with the science behind the changes will tell some of the hows and whys.

Activities

1. Follow suggestion No. 14 on page 36 of the unitext.

2. Follow suggestion No. 15 on page 36 of the unitext.

3. On pages 28 and 29 there are two charts illustrating Mendel's laws. In other books find similar charts. Divide those you find into two groups: those showing characteristics which blend and those which show characteristics that do not blend.

4. You have been told of the fixed number of chromosomes in the cells of peas, onions, and corn. From other books find the number of chromosomes in other plants.

5. You have been told of several characteristics which are dominant in certain plants. Examine other books and find some other characteristics which are dominant.

6. To more fully understand the 1:2:1 ratio mentioned in the last sentence of the second paragraph on page 27, carry on Activity No. 3 on page 99 of this manual.

7. Look at the chart on page 27 of DOMESTICATED ANIMALS, another unitext. The chart shows the results of crossing two purebred animals that differ in two easily seen characteristics. Look for similar charts for plants in other books.

Study Problems and Exercises

1. Mark these statements true or false. After each copy the first two words of a sentence in the text which backs up your judgment.

X (1) Heredity in plants is a field of study which has not yet been explored. (*But now*)

C (2) As they grow some plants produce soil poisons. (*Some plants*)

X (3) If plants can get plenty of oxygen, nitrogen, and hydrogen they are sure to grow well. (*There are*)

C (4) Growth regulators are chemicals. (*Scientists have*)

C (5) Plant hormones are chemicals. (*Growth-regulating chemicals*)

2. Make a title for the group of pictures on pages 26 and 27. (*P. 26, ¶ 4*)

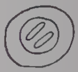
3. What chart illustrates Mendel's law of segregation? (*Chart on p. 28*)

4. What chart illustrates Mendel's law of dominance? (*Chart on p. 29*)

5. Copy the diagram on page 30 and put in labels to show that you understand the diagram.

6. Draw a mitosis diagram similar to the one at the top of page 31, but show only 4 chromosomes instead of 6 in each cell.

7. Draw a meiosis diagram similar to the one at the bottom of page 31, but show only 4 chromosomes instead of 6 in the first cell.

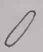
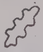
8. Make a circle like this to represent a body cell of each of the four o'clocks shown in the diagram on page 28: 

Color red each chromosome bearing a gene for red and leave white each chromosome bearing a gene for white.

9. Draw four reproductive cells of one of the red four o'clocks.

10. Draw four reproductive cells of one of the white four o'clocks.

11. Draw four reproductive cells of one of the pink four o'clocks.

12. Make for the chart on page 29 a diagram similar to the one you made in Exercise 8 for the chart on page 28. Use this symbol to stand for smoothness:  Use this symbol for wrinkledness: 

13. Mark these sentences true or false:

C (1) All the body cells of a single corn plant have the same number of genes and chromosomes.
C (2) All the body cells of all the corn plants in a field of corn have the same number of chromosomes.
X (3) All the body cells of all the corn plants in a field are sure to have the same combination of genes.
C (4) Mutations are believed to be due to changes in genes and chromosomes.
C (5) Cross-pollination helps make selection a workable way of improving plants.

VII. Where Our Cultivated Plants Came From

(pages 32-36)

Core Ideas

Most of the world's domesticated plants grew wild and were first cultivated in countries other than ours.

The regions that were the centers of early civilizations contributed a large percentage of our cultivated plants.

Most of our domesticated plants were tamed during the dawn of civilization.

Possible Approach

Ask the class to reread the first sentence of the first paragraph on page 4. Then ask how many of the class have ever seen wild tomatoes, wild peaches, wild cotton, wild wheat, etc. Ask for possible explanations. Let them check their suggestions by reading the first paragraph of the section.

Activities

1. Follow suggestion No. 16 on page 36 of the unitext.

2. Read in the *National Geographic Magazine* of July, 1947, an account of the history of some of our garden flowers.

3. Read in *Natural History* for March, 1946, the article, "Flowers from the Wilderness to Your Garden."

4. Keep a record of the plants or plant products you eat in the course of some one day. Make a map showing where the plants originated.

Study Problems and Exercises

1. Copy from page 32 a sentence which the maps on pages 32, 33, 34, and 35 illustrate. (*Either third or last sentence of the first paragraph on p. 32.*)

2. Suppose each of the following farmers were allowed to raise only plants which had their origin on his continent. After each name five plants he might raise:

Farmer in Europe
Farmer in Africa
Farmer in Asia
Farmer in North America
Farmer in South America

3. Name five garden flowers not mentioned on page 32 and tell where they originated. (*Map on inside covers*)

4. Mark these sentences true or false.

C (1) The origin of some of our cultivated plants is difficult to trace because man has brought about many changes in them since he first domesticated them.

C (2) Knowing about chromosomes helps us trace the ancestry of some of our plants.

X (3) Knowing where a plant originated satisfies our curiosity but is never useful in any other way.

C (4) The centers of early civilization contributed most of our crop plants.

X (5) Probably the plants we now cultivate will soon be replaced by plants we develop from wild plants that have not yet been domesticated.

Materials and Equipment

(See page 405)

Microscope 4
Prepared slides of mitosis 4
Flower pots
Seeds, bulbs, corms, fleshy roots, rhizomes, slips, tubers, runners, and leaves for experimenting with vegetative reproduction in plants
Foliage plants
Growth regulators 4
Seed and bulb catalogues
National Geographic, July, 1947
Natural History, November, 1943
Natural History, February, 1945
Natural History, March, 1946
DOMESTICATED ANIMALS

FOODS

(Note general information page 5)

I. INTRODUCTION (pages 3-5)

Core Ideas

Food differs greatly in different parts of the world.

Different diets account for some of the differences between peoples.

Food serves the same purposes for everyone.

Possible Approach

Write on the blackboard the sentence "We are what we eat." Lead the class to discuss what the sentence means and whether they know of any evidence to support it. Then ask them to check their ideas by reading the section. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activities

1. Follow suggestion No. 8 on page 36 of the unitext.
2. Choose some foreign country, and collect and mount pictures of foods typical of that country.
3. Collect specimens of grains which are used for food.
4. Read in *Man, Bread, and Destiny,* by C. C. and S. M. Furnas, about the food habits of our prehistoric ancestors (pages 3-27), and about some of the famous meals of earlier times (pages 231-6).
5. Assemble a collection of booklets and posters about nutrition. Many food manufacturers and organizations having to do with food have such material for distribution. Among them are:

National Dairy Council, 111 N. Canal St., Chicago 6, Ill.

National Livestock and Meat Board, 407 S. Dearborn St.,
Chicago 5, Ill.
Ralston Purina Co., St. Louis 2, Mo.

Study Problems and Exercises

1. Mark each of the following sentences "True" or "False":

C 1) Roast spiders, pickled ants, and smoked sea worms are considered delicacies in some parts of the world.
X 2) Wheat is the only grain from which bread is made.
X 3) People drink milk from no animal except the cow.
C 4) The picture on page 2 shows typical American food.
C 5) Different diets account for some of the differences between peoples.

2. Fill in the following table with data from the experiment described on page 4. Draw a conclusion from this experiment.

	Diet	Appearance of Individuals
Sikhs	(*Sour milk curds, leafy vegetables, potatoes, whole-wheat bread, meat*)	(*Tall, well built*)
Madrasi	(*Polished rice, red peppers, tamarinds, dried fish*)	(*Short, stunted*)
Rats—group 1	(*Sikh diet*)	(*Large, smooth-haired*)
Rats—group 2	(*Madrasi diet*)	(*Small as large mice*)

Conclusion: (*The Sikh diet was much better than the Madrasi.*)

3. In the study of the Masai and Kikuyu tribes, what effects of a poor diet were found among the Kikuyus? (*P. 5, ¶ 1*)

II. WHAT FOOD IS FOR (pages 6-8)

Core Ideas

Food serves as fuel to furnish energy for work and play and to keep our bodies warm.

The fuel value of a food is measured in calories.

A person's calorie requirement depends on his age, sex, and amount of activity.

Food furnishes the materials needed for body repair and growth.

Growth and repair mean the building of new cells.

Food furnishes materials which regulate body processes.

Possible Approach

Show a pair of young hamsters. Bring out the fact that, if the hamsters are to live and grow, they must have food. Write on the board the diet recommended for them. Then raise the question of what purposes their food serves—of why food is necessary for life and growth. Check by reading the first two paragraphs of the section.

Activities

1. Collect pictures to illustrate expenditure of energy by living things.

2. Mount pictures of a locomotive or an automobile and of a boy side by side. Make the pictures into a chart showing the purposes food serves for the boy and how these same needs are taken care of for the engine.

3. Put a lump of sugar on a piece of wire gauze and put it over the flame of a Bunsen burner. Do the same with a lump of suet. What happens to the sugar and suet? Does this experiment help you understand that some foods are fuels?

Study Problems and Exercises

1. What three main purposes does food serve? (*P. 6, ¶ 2*)

2. What action going on inside our bodies releases energy and warmth from the food we eat? (*P. 6, ¶ 4*)

3. What unit is used in measuring the amount of heat and energy our food produces? (*The calorie.*)

4. How many calories are furnished by each of the following desserts? (*See chart on inside back cover.*)

A dish of vanilla ice cream ______
Four pieces of fudge ______
A piece of mince pie ______
A dish of plain strawberries ______
One large apple ______

5. About how many calories should you have each day? (*Chart on page 7.*)

6. What happens when you eat enough food to furnish more than this amount? (*P. 7, ¶ 2*)

7. What would happen if you did not eat enough food to furnish the required amount of calories? (*P. 7, ¶ 2*)

8. How far short of an adequate diet, so far as calories are concerned, would two pounds of bread and a jug of water a week be? (*Would furnish less than 400 calories per day, which is about 2,100 calories too low.*)

9. Exactly what happens when the body is growing or is being repaired? (*New cells are being added.*)

10. Give three examples of the need for regulating materials in the diet. (*P. 8, ¶ 3*)

III. The Big Three (pages 9-14)

Core Ideas

There are six groups of food materials: carbohydrates, fats, proteins, vitamins, minerals, and water.

Carbohydrates, fats, and proteins make up the bulk of the solid part of our food.

Starches and sugars, the chief carbohydrates, serve as fuels.

Fats also serve as fuels.

Proteins can be burned to furnish energy, but their chief use in the body is for growth and repair.

Our diets should provide sizable amounts of carbohydrates, fats, and proteins.

Possible Approach

Raise the question of why there are several different foods in the hamster's diet, of why it would not be just as satisfactory to feed them more of only one of the foods. Let the class check their ideas by reading the first two paragraphs of the section and by examining the chart on the inside front cover.

Activities

1. Follow suggestion No. 2 on page 36 of the unitext.

2. Examine some cornstarch under a microscope. Notice the shape of the grains.

3. Follow suggestion No. 5 on page 36 of the unitext.

4. Follow suggestion No. 6 on page 36 of the unitext.

5. Follow suggestion No. 10 on page 36 of WHAT THINGS ARE MADE OF, another unitext in this series. The test is described on page 23 of that unitext.

6. Milk is a mixture. It is made up largely of water, fat, and protein. You can take it apart in this way: Get a half-pint bottle of milk. Pour the cream into a bottle. Add a few drops of lactic acid to it, put a cork in the bottle, and shake the bottle gently. Keep on shaking it until there is a lump of fat in the bottle. The lactic acid has made the fat separate from the rest of the cream, which is mostly water. Pour off the water. Take out the lump of fat. If you wash this in cold water and add a little salt to it, you will have a lump of good butter. Pour the rest of the milk into a bowl. Set the bowl in a pan of warm water. Dissolve a junket tablet in a spoonful of warm water. Stir it into the warm milk. Let the milk stand. Soon it will be solid like custard. Stir it with a spoon. It will separate into chunks of white material and a liquid that is mostly water. The white material is largely protein. Strain the mixture through a piece of clean cheesecloth. The white chunks will be left. These white chunks are cottage cheese.

Test the liquid drained from the cottage cheese for sugar. Does this test bear out the statement in the chart on page 11 that milk contains carbohydrate?

7. Take wheat flour apart. Add enough water to about half a cupful of white flour to make a stiff dough. Then cover the

dough with water and knead it under water for about five minutes. The water will become milky. Squeeze the dough as dry as possible and remove it from the water. Notice how tough and elastic it is. Burn a piece of it and notice the burned feather smell. The elastic material in flour is a protein called gluten.

Now test for starch the milky water in which you kneaded the dough. Examine a drop of it under a microscope.

Notice in the chart on page 11 of the unitext that white bread is more than half carbohydrate and that it contains a considerable amount of protein.

8. Estimate as closely as you can how many calories the luncheon pictured on page 2 would furnish each person.

Study Problems and Exercises

1. List the six groups of nutrients. Check the "big three." (*Carbohydrates, fats, proteins, minerals, vitamins, water.*)

2. Why are the nutrients which you checked above called the "big three"? (*P. 9, ¶ 3*)

3. Name the "big two" of the carbohydrates. (*P. 10, ¶ 2*)

4. What is meant by the statement that carbohydrates are "go" foods rather than "grow" foods? (*They furnish fuels for energy, not materials for growth.*)

5. Why can we say we are using stored sunlight when we get heat and energy from carbohydrates? (*P. 12, ¶ 1*)

6. Is fat a "go" food or a "grow" food? (*A "go" food.*)

7. Since a pound of fat furnishes more than enough energy for a day, why is it not a good idea to get all of our energy needs in this way? (*P. 13, ¶ 4*)

8. Is protein a "go" or "grow" food? (*P. 13, ¶ 5*)

9. Identify each of the following:

A form of carbohydrate stored in the liver.	(*Glycogen*)
A member of the "big three" of which white of egg is chiefly composed.	(*Protein*)
The building blocks of proteins.	(*Amino acids*)
The living material in the cells of our bodies.	(*Protoplasm*)
A carbohydrate which goes through our bodies unchanged.	(*Cellulose*)

10. In each of the following pairs of foods underline the one which has the higher percentage of protein.

Tapioca, Eggs
Halibut steak, Macaroni
Milk, Oranges
Ice cream, Beef
Oatmeal, Cheese
Shredded wheat, Spinach

11. In each of the following pairs of foods underline the one which has a higher percentage of usable carbohydrates:

Butter, Sugar
Ice cream, Asparagus
Honey, Celery
Lettuce, Cornflakes
Onions, Chicken
Lamb chops, Bread

12. In each of the following pairs of foods underline the one which has the higher percentage of fats:

Beef, Potatoes
Mayonnaise, Cream
Eggs, Peas
Apple, Pork chop
Banana, Ice cream
Walnuts, Jelly

13. How many calories would each of the following furnish?

Three large leaves of lettuce.	(*10*)
One-half cup of baked beans.	(*175*)
Two slices of American cheese.	*(200)*
One glass of whole milk.	(*160*)
Two slices of white bread.	*(100)*

IV. Minerals (pages 15-19)

Core Ideas

Minerals are needed for growth and repair.

Minerals are needed to help regulate body processes.

In our foods most of the mineral elements we need are in the form of compounds.

Of all the minerals we need, calcium is the one most likely to be found in insufficient amounts in our food.

Practically all our foods come either directly or indirectly from green plants, the mineral content of which depends largely on the soil in which they are raised.

Minerals are included in the so-called protective foods.

Possible Approach

Examine a bone. Raise the question of why it is so much harder than most parts of the body. Check by reading the first paragraph of the section.

Activities

1. Follow suggestion No. 4 on page 36 of the unitext.
2. The pictures on pages 15, 18, and 19 of the unitext show foods rich in calcium, iron, and phosphorus. Collect pictures to make similar charts of foods rich in copper and iodine.
3. Make a collection of as many of the necessary minerals as possible in their pure form.
4. Soak a chicken bone in weak hydrochloric acid. Enough of the calcium will be removed to make the bone rubbery. If the bone is long enough, it should be possible to tie it in a knot.

Study Problems and Exercises

1. The elements sodium and potassium would produce painful burns if they were to touch the skin; yet we need these elements in our diet. Explain. (*P. 15, ¶ 4*)

2. Mark these sentences "True" or "False":

X (1) Polished rice contains more minerals than unpolished rice.
C (2) The skin of potatoes contains more minerals than the inside.
C (3) There is enough iron in our bodies to make a medium-sized nail.
C (4) About 3¼ per cent of our bodies by weight is calcium.
C (5) Too much fluorine causes dark spots in the enamel of teeth.
X (6) A baby has more calcium in its body than an adult.
C (7) Our food plants get the minerals they have in them from the soil.
C (8) Minerals are often called protective foods.
X (9) A certain kind of fruit or vegetable always contains the same amounts of minerals no matter where it was grown.
X (10) Sodium is needed in the body to regulate the burning of food.

3. Name the elements that are needed for each of the following:

Make muscles work properly.	(*Potassium*)
Carry away waste carbon dioxide.	(*Zinc*)
Build good teeth and bones.	(*Calcium, Phosphorus*)
Build gastric juice.	(*Chlorine*)
Make the thyroid gland work properly.	(*Iodine*)
Build red blood cells.	(*Iron*)
Keep proper amounts of water in body tissues.	(*Sodium*)
Keep nerves and skin in good condition.	(*Magnesium*)

V. Vitamins (pages 20-25)

Core Ideas

Vitamins are protective foods since they help regulate body processes.

Diseases called deficiency diseases are caused by lack of vitamins.

Vitamins occur in foods in very small amounts.

A number of vitamins have been identified and studied, and more will probably be found.

Possible Approach

Tell the class that no dictionary printed in 1910 or earlier had the word vitamin in it. Let them suggest possible explanations and then find the right one by reading page 20.

Activities

1. Look up and read stories of the discoveries of the various vitamins.

2. The picture on page 23 of the unitext shows sources of the B group. Collect pictures of foods rich in thiamine, riboflavin, and niacin, and make separate charts for each of these B vitamins.

3. Look up and read stories centering around deficiency diseases.

Study Problems and Exercises

1. Underline the word in parentheses which correctly completes each sentence.

Vitamins were not known to exist until early in the (nineteenth, twentieth) century.

Animals are healthier when fed (pure, natural) nutrients.

The first scientist to succeed in getting vitamins from food was (Funk, Hopkins).

Xerophthalmia is a disease which affects the (muscles, eyes).

Vitamin B_1 is now known as (thiamine, niacin).

2. Place the appropriate number from the first column in the space in front of the condition caused by a deficiency of each vitamin.

1) Vitamin C
2) Niacin
3) Riboflavin
4) Vitamin A
5) Thiamine
6) Vitamin D

(*2*) Pellagra
(*1*) Scurvy
(*4*) Xerophthalmia
(*5*) Beriberi
(*6*) Rickets
(*3*) Premature old age

3. In the blank spaces write the names of the vitamins that do the things listed. In some cases more than one vitamin should be named.

(*Vitamins C and D*)	Help build strong teeth and bones.
(*Riboflavin, Vitamin A*)	Help bring about normal growth.
(*Vitamins A and C*)	Help bring about general good health.
(*Vitamin C*)	Help keep blood vessels in good condition.
(*Thiamine, Riboflavin*)	Help bring about the proper burning of fuel foods.

VI. WATER (page 26)

Core Ideas

Water is needed to help regulate body processes.

Water is also an important body-building material.

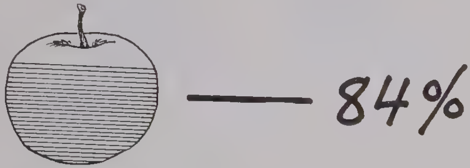
Our foods furnish some of the water we need, but we should drink a considerable amount besides.

Possible Approach

Ask the class to look again at the chart on the inside front cover and to find from it why no one could live on a diet of water alone. Call attention to the fact that other nutrients contribute toward growth and repair and toward the regulation of body processes and ask whether it would be safe to conclude that water is not a very important part of one's diet. Check by reading the initial paragraph of the section.

Activities

1. Follow suggestion No. 3 on page 36 of the unitext.
2. Make pictures of various fruits and vegetables indicating the proportion which is water, thus:



Study Problems and Exercises

1. Why is water important as a building material? (*All the cells of the body are made partly of water.*)
2. In what ways is water important as a regulator of body processes? (*P. 26, ¶ 2, lists seven ways.*)
3. How can one be sure to get plenty of water each day? (*P. 26, ¶ 4*)

VII. Balancing Your Diet (pages 27-29)

Core Ideas

Our diets should be well balanced; they should, that is, furnish adequate amounts of all the nutrients needed.

It is easier to balance a day's food if each of the three meals is well balanced.

Possible Approach

Have a day's meals set up on the demonstration table with food models. Ask the class to give their impression of the day's menu at a glance. Then check it by the Food Guide on page 28. Figure then its calorie value to find whether it would furnish enough fuel.

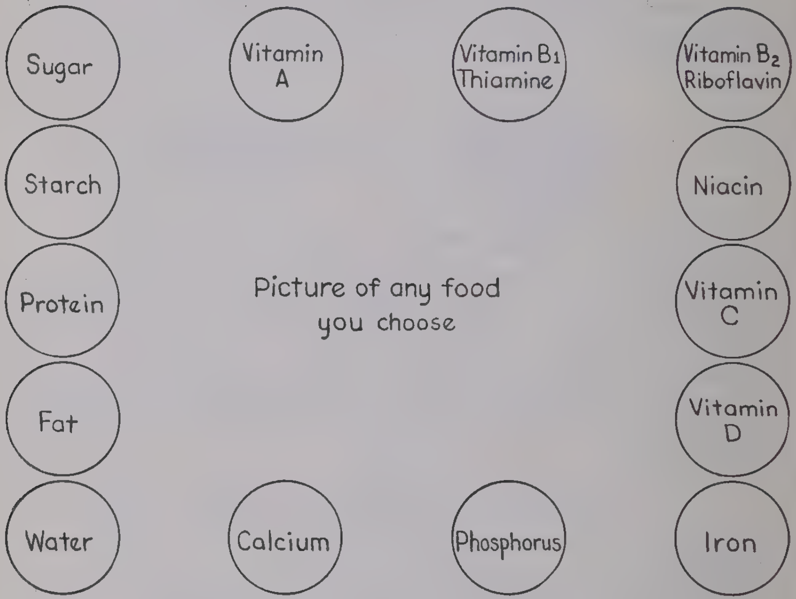
Activities

1. Look again at the luncheon pictured on page 2. Check to see which of the groups of foods listed in the Food Guide on page 28 are represented in it.

2. Follow suggestion No. 1 on page 36 of the unitext.

3. Make food models from magazine pictures of food. With these models set up a well-balanced meal.

4. Make a chart like the one below. Color the circles to make them stand out.



Then draw lines from the picture of the food to each food material which it contributes in significant amounts to our diet.

5. Make in class some simple food, e.g., egg salad sandwich, fruit cup, or dried uncooked fruit bars. Then make for it a chart like the one described above.

6. Check the diet being used for the hamsters. Make a chart showing as fully as possible what each item in their diet contributes.

7. Weigh the hamsters regularly to find whether the diet is bringing about gain in weight, as it should. Look for other evidences that the diet is well balanced—evidences such as thick, smooth coat; bright eyes; good temper; and alertness.

Study Problems and Exercises

1. Fill in the following chart as fully as you can from the charts and pictures in the book.

Food Items in a Day's Menu	Calories	Percentage of			Vitamins Present				Minerals Present				
		Protein	Fat	Carbohydrate	A	B Group	C	D	Calcium	Phosphorus	Iron	Copper	Iodine
Breakfast:													
1 medium-sized orange.....	*80*	*0.8*	*0.2*	*11.6*			*x*		*x*				
¾ cup cooked oatmeal*....	*100*	*2.7*	*1.2*	*11.1*		*x*				*x*	*x*	*x*	*x*
½ cup thick cream........	*400*	*2.2*	*40.0*	*3.5*	*x*			*x*	*x*	*x*			
1 tablespoon sugar.........	*50*	....	....	*100.0*									
1 egg*....................	*75*	*13.4*	*10.5*	.....	*x*	*x*		*x*	*x*	*x*	*x*	*x*	*x*
3 small slices broiled bacon.	*50*	*16.7*	*50.0*	.....		*x*							
1 glass vitamin D milk.....	*160*	*3.3*	*4.0*	*5.0*	*x*	*x*		*x*	*x*	*x*			
1 slice white bread.........	*50*	*9.2*	*1.3*	*53.1*		*x*				*x*	*x*	*x*	
1 square butter............	*75*	*1.0*	*81.0*	.....	*x*			*x*					
Lunch:													
½ cup cooked macaroni*...	*90*	*3.0*	*1.5*	*15.8*									*x*
1 slice American cheese.....	*100*	*24.4*	*34.4*	*.6*	*x*	*x*			*x*	*x*			
3 large leaves lettuce.......	*10*	*1.2*	*0.2*	*2.9*	*x*	*x*	*x*		*x*		*x*	*x*	
1 medium-sized tomato*....	*25*	*1.0*	*0.3*	*4.0*	*x*	*x*	*x*						*x*
1 large apple..............	*100*	*.4*	*.5*	*14.2*			*x*		*x*				
1 glass vitamin D milk.....	*160*	*3.3*	*4.0*	*5.0*	*x*	*x*		*x*	*x*	*x*			
1 piece angel food cake.....	*315*												
Dinner:													
1 medium-sized serving lean beef*.............	*150*	*21.3*	*7.9*	.....		*x*				*x*	*x*	*x*	*x*
1 medium-sized potato*....	*100*	*2.0*	*0.1*	*19.1*		*x*	*x*		*x*	*x*	*x*	*x*	*x*
3 stalks celery*...........	*20*	*1.3*	*0.2*	*3.7*	*x*	*x*	*x*		*x*	*x*	*x*	*x*	*x*
¾ cup green beans*.......	*40*	*2.4*	*0.2*	*7.7*	*x*	*x*	*x*		*x*	*x*	*x*	*x*	*x*
1 slice white bread.........	*50*	*9.2*	*1.3*	*53.1*		*x*				*x*	*x*	*x*	
1 square butter............	*75*	*1.0*	*81.0*	.....	*x*			*x*					
1 glass vitamin D milk.....	*160*	*3.3*	*4.0*	*5.0*	*x*	*x*		*x*	*x*	*x*			
1 piece lemon meringue pie.	*450*												

Total calories: *2885*

*Seasoned with iodized salt.

2. Judging from the number of foods in this menu containing each required nutrient, and judging from the information in the Food Guide on page 28, do you think this a well-balanced menu?

3. Is the total number of calories the correct daily requirement for a person of your age and sex?

4. Make any comment or criticism of this menu that you can.

VIII. Food Fads and Fallacies (pages 30-31)

Core Ideas

There are many mistaken ideas about foods.

Before following any new food fad one should find out whether it has a sound basis.

Possible Approach

Call attention to the title of the section and to the pictures on page 31. Ask the class to suggest reasons for using those particular pictures to illustrate the section. Let them find by reading whether any of the reasons they have suggested are the right ones.

Activities

1. Make a chart to suggest food fallacies in addition to those suggested by the pictures on page 31.

2. Choose some idea about foods and set up a plan for determining whether it is a fallacy or whether there is scientific backing for it.

Study Problems and Exercises

1. Mark each of the following sentences "True" or "False":

X 1) You should not drink water with meals.
C 2) Water makes the digestive juices flow more freely.
X 3) Orange juice and milk should never be drunk at the same meal.
X 4) If milk curdles in the stomach, you will have indigestion.
X 5) Ice cream and fish at the same meal form a poisonous combination.
X 6) Proteins and carbohydrates should never be eaten together.

C 7) Spinach contains an acid which makes its calcium almost unusable.

2. Name a food which refutes the argument that carbohydrates and proteins should never be combined in a meal. (*Milk*)

IX. KEEPING FOODS FIT TO EAT (pages 32-35)

Core Ideas

To be kept fit to eat, foods must be protected from yeasts, molds, and bacteria.

Among the ways of preserving foods are drying, dehydration, refrigeration, quick-freezing, preserving with salt, preserving with sugar, canning, and pasteurizing.

Some of our ways of preserving foods lower their vitamin content.

Minerals and vitamins are often lost in cooking.

Possible Approach

Show foods that have been spoiled by bacteria, yeasts, or molds, e.g., moldy bread or fruit, decayed fruit, sour milk, and fermented fruit juice. Ask what problem these foods suggest. Compare their statement of the problem with the section heading. Then, discuss each of the spoiled foods shown from the standpoint of what caused it to spoil. Ask the class to check their ideas by reading.

Activities

1. Follow suggestion No. 7 on page 36 of the unitext.
2. Follow suggestion No. 5 on page 36 of DEPENDENT PLANTS, another unitext in this series.
3. Follow suggestion No. 6 on page 36 of DEPENDENT PLANTS.
4. Follow suggestion No. 7 on page 36 of DEPENDENT PLANTS.
5. Follow suggestion No. 8 on page 36 of DEPENDENT PLANTS.
6. Follow suggestion No. 9 on page 36 of DEPENDENT PLANTS.
7. Follow suggestion No. 10 on page 36 of DEPENDENT PLANTS.

8. Follow suggestion No. 11 on page 36 of DEPENDENT PLANTS.

9. Follow suggestion No. 12 on page 36 of DEPENDENT PLANTS.

10. Set up an exhibit showing the various ways in which foods are kept fit to eat.

Study Problems and Exercises

1. What do the pictures on page 33 have to do with keeping foods fit to eat? (*Bacteria, yeasts, and molds cause foods to spoil.*)

2. In the blank space in front of each sentence place the letter:

B if it is true of bacteria.
Y if it is true of yeasts.
M if it is true of molds.
N if it is true of none.
A if it is true of all.

(*A*) They cause food to spoil.
(*N*) They are animals.
(*A*) They are small, colorless plants.
(*N*) They are green plants.
(*N*) They always make their own food.
(*Y*) They use up sugar in fruit juice and leave alcohol and carbon dioxide in its place.
(*M*) They add flavor to several kinds of cheese.
(*B*) They cause vegetables or fruits to rot and meat to decay.
(*B*) They may make food very poisonous.
(*A*) They are distributed through the air.

3. Name at least one method of keeping foods fit to eat suggested by each of the following facts:

Bacteria, yeasts, and molds cannot grow in the absence of moisture.	(*Drying; dehydrating*)
Bacteria, yeasts, and molds cannot grow in extremely low temperatures.	(*Quick-freezing; refrigeration*)
Bacteria, yeasts, and molds	

cannot stand extremely high temperatures.	(*Cooking; pasteurizing; canning*)
There is no such thing as spontaneous generation; that is, living things must come from living things much like themselves. Bacteria, for example, cannot appear in food and spoil it unless there is some way for bacteria to get into the food.	(*Canning*)
Living cells are made largely of water.	(*Preserving with salt*)

4. How may vitamins be lost from foods? (*P. 35, ¶¶ 1-2*)
5. How may minerals be lost from foods? (*P. 35, ¶ 2*)

Materials and Equipment

(See page 405)

Dependent Plants
What Things Are Made Of
Man, Bread, and Destiny
by C. C. and S. M. Furnas
A pair of hamsters
Picture of a locomotive or an automobile
Picture of a boy
Wire gauze 4
Bunsen burner 4
Test tubes 4
Forceps 4
Dissecting needle 4
Cheesecloth 1
Sheet of iron 4
A balance 4
Food models
Microscope 4
Petri dishes 4
Tincture of iodine 3
Fehling's solution A 4
Fehling's solution B 4
Lactic acid 4
Junket tablets 3
Weak hydrochloric acid 4
Chicken bone
Moldy bread or fruit
Decayed fruit
Gelatin or agar-agar 3, 4
Grape juice
Yeast
Lump of sugar
Lump of suet
Bread
Potato
Cornstarch
Bacon
Lard
Cream
Peanuts
Olive oil
Salad dressing
American cheese
Butter
Hard-boiled egg
Beef
Peas
Onion
Apple
Orange
Milk
Wheat flour
A bone
Lettuce
Carrot
Sour milk
Fermented fruit juice

HOW WE ARE BUILT

(Note general information page 5)

I. Cells and Systems (pages 3-4)

Core Ideas

The human body is a complicated machine.

Like all other living things, our bodies are made up of cells.

In our bodies, cells are grouped into tissues, tissues into organs, and organs into systems.

Possible Approach

Raise the question of why it is important for us to know how we are built. After a discussion ask the class to find a sentence on the first two pages which summarizes their discussion. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activities

1. Follow suggestion No. 1 on page 36 of the unitext.
2. Follow suggestion No. 2 on page 36 of the unitext.
3. Scrape a few cells from the inside of your cheek, mount them on a slide, and examine them with a microscope. Compare them with the epithelial cell pictured in the unitext.
4. Examine prepared slides of cells of different kinds.
5. Examine a piece of beef and identify the different kinds of tissue in it. Look for muscle tissue, fatty tissue, connective tissue, and bone tissue.

Study Problems and Exercises

1. Fill the blank in this sentence: All living things are built of tiny units of living material called (*cells*) .

2. Check each true statement: The cells of the human body

1) are all of the same size and shape. ( )
2) are small divisions of living material. (√)
3) increase in number as the body grows larger. (√)
4) are of many different kinds. (√)

3. Number the following in the order of their complexity, marking the simplest 1. Give an example of each.

(*4*) systems ____________________
(*2*) tissues ____________________
(*1*) cells ____________________
(*3*) organs ____________________

4. Tell in one sentence the main purpose of studying a unit on how we are built. (*P. 4, ¶ 4*)

II. THE BODY FRAMEWORK (pages 5-7)

Core Ideas

Human beings belong to the great group of animals with backbones.

The skeleton serves as a framework for the body, protects our internal organs, and helps in carrying out many movements.

There are several different types of joints in the body.

Possible Approach

Show the skeleton of some animal. Ask the class to identify the animal. Then raise the question of why it is possible to identify an animal from its skeleton. Let the group check its answers to this question by reading the first paragraph of the section.

Activities

1. Follow suggestion No. 3 on page 36 of the unitext.
2. Follow suggestion No. 4 on page 36 of the unitext.
3. Place a bone in vinegar or in some other weak acid and note the effects.
4. Out of clay make models to show the three kinds of joints.
5. Examine a long bone that has been cut lengthwise so that you can see the cavity.

Study Problems and Exercises

1. Fill the blanks in these sentences:

1) Bone surfaces that rub together are covered by a gelatine like material called *(cartilage)*.
2) Another name for the breastbone is the *(sternum)*.
3) The backbone is made up of bones called *(vertebrae)*.
4) The bones are held together at the movable joints by *(ligaments)*.
5) Some of the joints are movable, others *(immovable)*.

2. What is the point to the pictures on page 5? *(P. 5, ¶ 1)*

3. What point is the picture on page 6 meant to emphasize? *(P. 6, ¶ 4)*

4. In each of these groups of four terms there is one term which does not belong in the group. Cross out the term which does not belong and tell why it does not.

1) ~~vertebra~~
skull
shoulder girdle
pelvis
(A vertebrae is a single bone.)

2) ~~ligament~~
hinge
ball and socket
pivot
(A ligament is not a joint.)

3) cartilage
bone
connective tissue
~~sinus~~
(Sinus is not the name of a kind of tissue.)

4) hip
~~rib~~
knee
elbow
(A rib is not a joint.)

5) man
frog
~~crab~~
hippopotamus
(The crab does not have a backbone.)

6) femur
patella
humerus
~~spinal column~~
(The spinal column is made up of many bones.)

7) femur
tibia
fibula
~~sternum~~
(The sternum is not a leg bone.)

8) femur
shoulder blade
~~breastbone~~
kneecap
(There is only one breastbone in a person's body.)

5. This question was asked recently on "Information Please": "If a man should fall down and really break every bone in his body, how many would he break?" How many? (*P. 5 ¶ 2*)

III. THE MUSCLES (pages 8-9)

Core Ideas

Practically all the movements of the body are brought about by muscles.

Muscles bring about movement by contracting.

We can control some muscles—the voluntary muscles—while we have no control over others—the involuntary muscles.

Possible Approach

Ask the class whether they think it would be possible for them to sit for a minute without moving a muscle. After a brief discussion, let them check their ideas by reading the first three sentences of the section.

Activities

1. Follow suggestion No. 5 on page 36 of the unitext.
2. Locate at least twenty-five voluntary muscles in your body.

Study Problems and Exercises

1. Copy the picture of the muscle cell on page 4. Make another picture to show how this same cell would look if the muscle of which it was a part was contracting. (*P. 8, ¶ 2*)

2. Mark the following sentences true or false. In the blank after each write the first two words of the sentence in the text which backs up your decision.

C (1) Muscles may be fastened to bones by tendons. (*Others are*)
C (2) The heart is made up partly of muscle tissue. (*Muscle tissue*)
X (3) At times all the muscles in your body are at rest. (*Even when*)
X (4) The Achilles tendon is in the wrist. (*You have*)
C (5) The muscles in your arm are voluntary muscles. (*The muscles*)

IV. THE CIRCULATORY SYSTEM (pages 10-16)

Core Ideas

The blood brings food and oxygen to every cell in the body and carries wastes away.

We cannot live unless the blood does its work.

The circulatory system is made up of the heart, blood vessels of three kinds (arteries, veins, and capillaries), and the blood.

The blood contains trillions of red blood cells, which carry oxygen.

The blood contains billions of white blood cells, which make up our army of defense against disease germs.

Possible Approach

Make the point that it is common knowledge that the heart must keep working if we are to stay alive. Raise the question of why the work of the heart is so important. Let the class check its ideas by reading the first two paragraphs of the section.

Activities

1. Follow suggestion No. 6 on page 36 of the unitext.
2. Follow the first part of suggestion No. 7 on page 36 of the unitext.
3. Look at prepared blood slides through the microscope.
4. Make blood slides of your own and look at them through the microscope.
5. Compare the circulatory systems of fishes, frogs, birds, and man. Most biology books have diagrams that will help you.
6. Ask a physician or nurse for information about how blood counts are made.
7. Find and read material on blood groupings.

Study Problems and Exercises

1. For what does the black stand in the lower diagram on page 10? (*P. 13, ¶ 1*) For what does the gray stand? (*P. 13, ¶ 1*)

2. Suppose you are tracing a drop of blood from the left auricle to the head and back to the left auricle. Number the

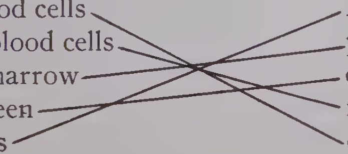
things listed below in the order in which the drop of blood would travel through them.

(*3*) artery
(*8*) artery
(*5*) vein
(*10*) vein
(*9*) capillaries of lungs
(*4*) capillaries of head
(*1*) left auricle
(*2*) left ventricle
(*6*) right auricle
(*7*) right ventricle

3. In the spaces after the statements below tell what kind or kinds of blood vessels are described.

They have valves in them.	(*Veins*)
They have thinner walls than other blood vessels.	(*Capillaries*)
Some of them carry bright-red blood.	(*Veins, arteries, capillaries*)
Some of them carry blood that has lost its oxygen.	(*Veins, arteries, capillaries*)
They carry blood away from the heart to the capillaries.	(*Arteries*)
They carry blood from the capillaries to the heart.	(*Veins*)
They have more muscles in their walls than do other blood vessels.	(*Arteries*)
They are the smallest of the blood vessels.	(*Capillaries*)
They are the most numerous of the blood vessels.	(*Capillaries*)
They carry blood containing red blood cells.	(*Veins, arteries, capillaries*)
They carry plasma.	(*Veins, arteries, capillaries*)
They carry blood containing white blood cells.	(*Veins, arteries, capillaries*)

4. Match these parts of sentences:



Red blood cells	help make blood clot.
White blood cells	produces red blood cells.
Bone marrow	destroys worn-out red cells.
The spleen	fight disease.
Platelets	carry oxygen.

5. When a doctor suspects that a patient has some infection, he usually makes a blood count. Copy a sentence which explains why. (*When disease germs attack us, the number of white blood cells may be doubled or even tripled.*)

6. Underline once the number which tells approximately how many times your heart beats during one science period.

Underline twice the number which tells approximately how many red blood cells you have.

Underline three times the number which tells approximately how many white blood cells you have.

Underline four times the number which tells how many chambers you have in your heart.

2
4
6

200
400
600

2,500
4,500
6,500

50,000,000,000
50,000,000
20,000,000,000
20,000,000,000,000

7. What does the picture on page 12 have to do with the circulatory system? (*P. 10, ¶ 4*)

8. Make a title for the picture on page 14. (*Taking Your Pulse*)

9. Make a title for the right-hand picture on page 15. (*White Blood Cells*)

10. Mark these sentences true or false:

C (1) Capillaries connect arteries with veins.
X (2) When disease germs attack us, the number of red blood cells doubles or even triples.
C (3) Hemoglobin gives the red blood cells their color.
X (4) The three kinds of blood vessels are the arteries, the ventricles, and the veins.
C (5) The liquid part of the blood is called plasma.
X (6) White blood cells carry oxygen.
X (7) Arteries always carry bright-red blood.
C (8) There are more red cells than white.
C (9) When the doctor feels your pulse, he is really counting your heartbeats.
C (10) The blood receives wastes from the cells through the walls of the capillaries.

V. The Respiratory System (pages 17-19)

Core Ideas

By breathing we take in oxygen and get rid of waste carbon dioxide and moisture.

The respiratory system is made up of the nose, throat, voice box, windpipe, bronchial tubes, and lungs.

We cannot live unless the respiratory system does its work.

Possible Approach

Ask the class how the length of time we can go without breathing compares with the length of time we can go without eating. (*The time we can go without breathing is, of course, much shorter.*) Then ask for suggestions as to why breathing is so important. Check the suggestions by rereading the first paragraph on page 10 and by reading the first paragraph of this section. To find out why a constant supply of oxygen is needed by every cell refer to paragraphs 4, 5, and 6 on page 5 of Keeping Well, another unitext.

Activities

1. Follow the last part of suggestion No. 7 on page 36 of the unitext.

2. Follow suggestion No. 8 on page 36 of the unitext.

3. Follow suggestion No. 9 on page 36 of the unitext.

4. Use a demonstration model to show how the diaphragm helps us breathe. (You can make such a model from a bell jar which has a small opening at the top, two small balloons, a piece of rubber dam, a one-holed rubber stopper, and a Y-shaped glass tube.)

5. Measure the distance around your chest just after exhaling and again just after inhaling.

6. Read in reference books about some of the common diseases of the respiratory system.

7. Cut from colored paper shapes of the different respiratory organs and fit them together to show relationships.

8. Devise apparatus by which you can measure the lung capacity of each member in the group.

Study Problems and Exercises

1. The picture on page 12 might have been used to illustrate what sentence in this section? (P. 18, 2, sentence 2.)
what sentence in this section? (*P. 18,* ¶ *2, sentence 2*)

2. Number these parts of the respiratory system in the order in which air passes through them when breathed out from the lungs.

(*1*) lungs
(*4*) larynx
(*2*) bronchial tubes
(*6*) nose
(*3*) windpipe
(*5*) throat

3. What do these four phrases describe? (*Exhaled air*)
Contains the same amount of nitrogen as normal
Contains less oxygen than normal
Contains more carbon dioxide than normal
Contains more water vapor than normal

4. Check each correct ending for the sentence:
A scientific reason for breathing through the nose instead of through the mouth is that

a) one can get more air with less difficulty by breathing through the nose. ( )
b) mouth breathing interferes with talking. ( )
c) the air is warmed before it enters the lungs if inhaled through the nose. (√)
d) many impurities are removed from the air which passes through the nose. (√)

5. Upon what idea is the method of artificial respiration pictured on pages 18 and 19 based? (*P. 18,* ¶ *3*)

VI. The Digestive System (pages 20-24)

Core Ideas

The digestive system prepares the food we eat for distribution to all parts of the body.

Digestion is a series of physical and chemical changes.

The digestive system includes the mouth, throat, esophagus, stomach, liver, pancreas, small intestine, and large intestine.

The various parts of the digestive system produce several digestive juices, which play important roles in digestion.

Possible Approach

Show an apple, a sandwich, or some other common article of food. Raise the question of how the food shown can reach every part of the body—the fingertips, for example. How can it be carried to the fingertips? What must happen before it can enter the blood? How can it be made into a liquid? Check by reading the first paragraph of the section.

Activities

1. Follow suggestion No. 10 on page 36 of the unitext.

2. In the unitext FOODS read about the Big Three—carbohydrates, fats, and proteins. From this section in HOW WE ARE BUILT find out where each is digested.

3. Chew a soda cracker long enough to notice a sweet taste.

4. Experiment to find out whether the taste buds with which you taste sweet things are scattered all over the surface of your tongue or whether they are confined to certain areas.

5. Try dissolving small pieces of various kinds of food in water.

6. Make a mixture resembling gastric juice by adding ten drops of hydrochloric acid and ten drops of lactated pepsin to half a test tube of water. See whether it will digest white of egg by putting some finely chopped bits of white of egg in the solution and standing the test tube in a warm place for a day or so.

7. Get a small piece of beef liver from the meat market and examine it.

8. With clay, mold a surface to represent the inside wall of the intestine. Notice the increased absorption surface because of the villi.

9. In reference books read about diseases of the digestive system.

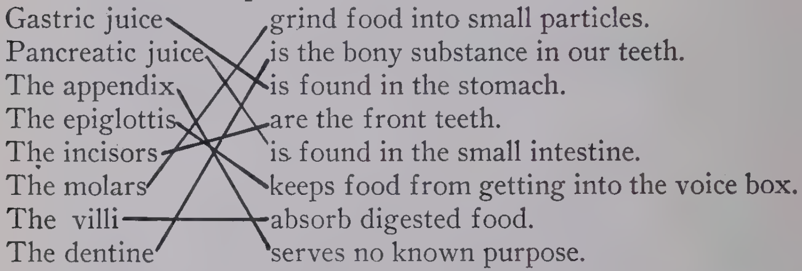
10. Cut from colored paper shapes of the different digestive organs in their proportionate size. Fit them together to show relationships.

Study Problems and Exercises

1. List in a column below, the parts of the digestive system labeled in the diagram on page 20. Tell after each what part it plays in digestion. Underline once those parts through which the food being digested actually passes.

1)	*(Salivary glands)*	*(P. 21, ¶ 1)*
2)	*(Epiglottis)*	*(P. 21, ¶ 4)*
3)	*(Esophagus)*	*(P. 22, ¶ 1)*
4)	*(Liver)*	*(P. 23, ¶ 5)*
5)	*(Stomach)*	*(P. 23, ¶ 1)*
6)	*(Pancreas)*	*(P. 24, ¶ 1)*
7)	*(Gall bladder)*	*(P. 23, ¶ 5)*
8)	*(Small intestine)*	*(P. 24, ¶¶ 2 and 3)*
9)	*(Large intestine)*	*(P. 24, ¶ 4)*
10)	*(Appendix)*	*(P. 24, ¶ 4)*
11)	*(Rectum)*	*(P. 24, ¶ 4)*

2. Match these parts of sentences:



Gastric juice	grind food into small particles.
Pancreatic juice	is the bony substance in our teeth.
The appendix	is found in the stomach.
The epiglottis	are the front teeth.
The incisors	is found in the small intestine.
The molars	keeps food from getting into the voice box.
The villi	absorb digested food.
The dentine	serves no known purpose.

3. Make a title for the diagram at the top of page 23. (*Food Being Pushed down the Esophagus*)

4. Trace a roast beef sandwich (bread, butter, roast beef) through your digestive system. Tell what part of it would be digested in each of your digestive organs and by what means.

5. Check all the correct endings for the following sentences:

a) The chief purposes of digestion of food in the human body are

1) to make the food taste better. ( )
2) to make the food soluble. (√)
3) to change the composition of the food so that it can be used by the body. (√)
4) to provide work for the digestive organs. ( )

b) In the process of digestion
  1) the salivary glands add saliva to the food, and this fluid changes starch to sugar. (√)
  2) proteins are digested only in the stomach. ( )
  3) the muscles of the stomach are very active. (√)
  4) the liver plays a part. (√)

c) If our digestive organs are in proper working condition,
  1) all of the food we eat will be made soluble. ( )
  2) there will be no wastes to be eliminated by the excretory system. ( )
  3) the respiratory system will have no work to do. ( )
  4) the food we eat will be used to the best advantage by the body. (√)

6. Fill the blank in this sentence: The organs that tell us whether food is sweet, sour, salty, or bitter are the (*taste buds*).

VII. The Urinary System (page 25)

Core Ideas

The urinary system handles much of the waste produced by the body.

The urinary system consists of the kidneys, ureters, bladder, and urethra.

Unless the urinary system can do its work, we cannot live.

Possible Approach

Ask some member of the group to move his arms up and down rapidly several times. Point out that in the muscles of his arms food is burned to furnish the energy needed and that wastes are produced just as wastes are produced by all burning. Ask for any ideas the class has as to the steps by which the wastes are got rid of. Let them then try to find support for their ideas on page 25.

Activity

Get a lamb or pork kidney from the meat market and examine it.

Study Problems and Exercises

1. Name the organs in the urinary system. (*Kidneys, bladder*)
2. What purpose does the urinary system serve? (*P. 25, ¶ 1*)
3. How important is the urinary system? (*P. 25, ¶ 3*)
4. Mark the following sentences true or false:

X (1) The kidneys are in the chest.
C (2) There is a large artery leading into each kidney.
C (3) There is a large vein leading from each kidney.
C (4) The kidneys contain many capillaries.
C (5) Urine contains waste material.

VIII. The Endocrine Glands (pages 26-28)

Core Ideas

The endocrine glands manufacture hormones, which control various body processes.

Illnesses of various kinds are due to failure of the endocrine glands to function properly.

Possible Approach

Call attention to the pictures on page 26. Ask for suggestions as to what brings about such differences in height. Check by reading the first four paragraphs of the section.

Activities

1. Make a chart for the bulletin board to show the location of the ductless glands. Use cuttings from colored paper for the glands.

2. Find and read a fuller account of the discovery that insulin can be used to control diabetes.

Study Problems and Exercises

1. Fill in the chart on the following page:

Name of Gland	Located Where	Functions of Its Hormones
Pituitary	(*P. 26, ¶ 4*)	(*P. 26, ¶¶ 3, 5*)
Thyroid	(*P. 27, ¶ 1*)	(*P. 27, ¶ 1*)
Parathyroids	(*P. 27, ¶ 2*)	(*P. 27, ¶ 2*)
Adrenal	(*P. 27, ¶ 3*)	(*P. 27, ¶ 3; p. 28, ¶ 1*)
Islands of Langerhans	(*P. 28, ¶ 2*)	(*P. 28, ¶ 2*)

2. Make a title for the picture on page 26 that will show its connection with the text. (*Good and Bad Functioning of the Pituitary Gland*)

3. Make a title for the picture on page 28 that will show its connection with the text. (*A Case Where the Adrenal Glands May Help*)

IX. THE NERVOUS SYSTEM (pages 29-33)

Core Ideas

Much of the work of the body is controlled by the nervous system.

The nervous system is extremely complicated.

The nervous system consists of the brain, the spinal cord, and the nerves.

Of some of the messages which travel over our nerve pathways we are conscious; of others we are not.

Habits are formed when the same message travels repeatedly over the same nerve pathway.

Possible Approach

Ask some member of the group to eat a piece of candy at the same time that he writes on the blackboard a sentence that you read to him. Ask the class to list the activities being carried on by the pupil. Refer the class to page 29 for possible additions to the list. Then ask what sentence on page 29 is illustrated by the pupil's activities (*p. 29, ¶ 3, sentence 1*).

Activities

1. Follow suggestion No. 11 on page 36 of the unitext.
2. Examine a model of the brain.
3. Examine models of the ear and eye.
4. Compare the human eye with the eye of the grasshopper.
5. Read about the nervous systems of some of the simpler animals—insects, for example.

Study Problems and Exercises

1. List five other tasks your nervous system is taking care of at the same time that you are writing the answer to this question. (*P. 29, ¶ 3*)

2. What connection does the picture on page 31 have with this section of the book? (*P. 30, ¶ 2*)

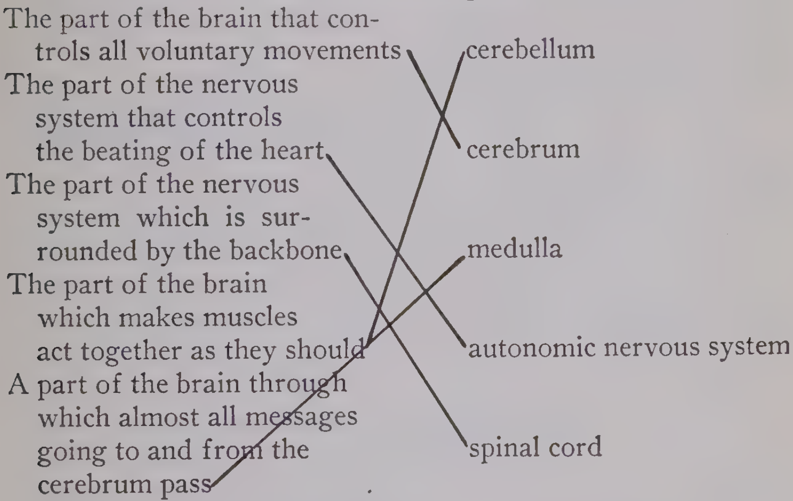
3. Mark these sentences true or false. After each write the first two words of the sentence which backs up your rating.

C (1) Much of the work of the body is controlled by the nervous system. (*Most of*)
X (2) The cerebellum is the largest division of the brain. (*As the*)
C (3) All our thinking is done by the cerebrum. (*With the*)
X (4) We are conscious of all the messages which travel over the nerves of our bodies. (*We do*)
X (5) A nerve cell looks very much like a muscle cell. (*They are*)
C (6) Forming a habit means wearing a nerve pathway. (*When you*)
X (7) A nerve is a single nerve fiber. (*The nerves*)
X (8) A nerve can carry messages of only one kind. (*But in*)
X (9) The brain is a part of the autonomic nervous system. (*It is*)
X (10) A nerve fiber is never more than an inch long. (*A nerve*)

4. Complete this chart:

Sense	Location of Nerve Endings	Part of the Brain to Which the Message Goes
Seeing	Retina of eye	(*P. 30,* ¶ *4*)
Hearing	(*P. 32,* ¶ *5*)	(*P. 30,* ¶ *4*)
Smelling	(*P. 33,* ¶ *1*)	(*P. 30,* ¶ *4*)
Tasting	(*P. 33,* ¶ *2*)	(*P. 30,* ¶ *4*)
Touching	(*P. 33,* ¶ *3*)	(*P. 30,* ¶ *4*)

5. Match these names and descriptions.



The part of the brain that controls all voluntary movements

The part of the nervous system that controls the beating of the heart

The part of the nervous system which is surrounded by the backbone

The part of the brain which makes muscles act together as they should

A part of the brain through which almost all messages going to and from the cerebrum pass

cerebellum

cerebrum

medulla

autonomic nervous system

spinal cord

X. THE SKIN (pages 34-35)

Core Ideas

The skin serves to protect the tissues beneath it.

The skin is far more complicated than it looks to be.

The sweat glands in the skin help to regulate body temperature.

A person's skin and hair have a great deal to do with his appearance.

Possible Approach

Ask for suggestions as to why the pictures on page 35 were included in the book. Check by reading the last paragraph on page 35. Then raise the question of what other purposes the skin serves. Check by reading the first paragraph of the section.

Activities

1. Follow suggestion No. 12 on page 36 of the unitext.

2. Look at a prepared slide of skin tissue under the microscope.

3. On a large sheet of paper let everyone in the group put his fingerprint. Use a regular stamp pad.

4. Examine the skin on the back of your hand with a strong magnifying glass.

Study Problems and Exercises

1. Make five true-false statements that will call attention to the main points in this section. Indicate whether each statement is true or false.

2. List the parts of the skin named in the diagram on page 34. What fact about the skin does this list make clear? (*The skin is very complicated.*)

3. Why can a person be identified by his fingerprints? (*P. 34, ¶ 1*)

Materials and Equipment

(See page 405)

Microscope 4
Prepared slides of cells, blood, and skin tissue 4
Animal skeletons 4
Glass tube 4
Test tubes 4
Demonstration model of diaphragm 4
Tape measure
Models of human brain, ear, and eye 4
Magnifying glass 4
Limewater 4
Hydrochloric acid 4
Lactated pepsin 4
White of egg 2
Soda crackers 2
Beef liver 2
Piece of beef 2
Lamb or pork kidney 2
Candy 2
A chicken bone 2
Vinegar or some weak acid 2, 4
Modeling clay 5
A long bone cut lengthwise 2
Colored paper 5
Stamp pad 8
Keeping Well
Foods

INSECT FRIENDS AND ENEMIES

(Note general information page 5)

I. INTRODUCTION (page 3)

Core Ideas

Many insects help us.

Many insects harm us.

Insects are our greatest rivals.

The insects which help or harm us deserve no credit or blame for doing so.

Thinking of insects as friends and enemies is a selfish viewpoint.

Possible Approach

Tell the class that a few years ago there appeared in one of our magazines (*American Magazine,* March, 1928) an article called "Greatest War of All Time—Man against the Insects." Discuss the questions: What truth is there in this heading? Is the war against all insects or against only some insects? Give the class copies of the unitext. Let them check their ideas by reading paragraphs 1, 2, and 5 on page 3. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activities

1. Follow suggestion No. 1 on page 36 of the unitext.
2. Follow suggestion No. 4 on page 36 of the unitext.
3. Notice that most of the pictures in the unitext come from the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture. This bureau publishes many pamphlets about our insect friends and enemies. If you are interested in finding out more about our insect friends and enemies than the

unitext tells you, get a list of publications from the Bureau of Entomology and Plant Quarantine and then order those you decide you want.

Study Problems and Exercises

1. Why should the picture on page 2 be included in a book about insect friends and enemies? (*P. 3, ¶ 2*)

2. Why should the picture on page 5 be included in a book about insect friends and enemies? (*P. 3, ¶ 1*)

3. In five short sentences, give the main ideas of page 3. (*See Core Ideas.*)

II. WHAT IS AN INSECT? (page 4)

Core Ideas

All full-grown insects have three pairs of legs and one pair of antennas.

All insects have an outside skeleton made of chitin.

The body of an insect is divided into three distinct regions—the head, the thorax, and the abdomen.

Most insects have one pair of compound eyes and two pairs of wings.

Some insects have rather complicated life-histories and have very different appearances at different stages.

Possible Approach

Show the class pictures of several different kinds of animals, among them two or more insects. Let the class try to pick out the insects in the group. Ask how they recognized the insects. Let them check their ways of identifying an insect by reading the first two paragraphs of "What Is an Insect?"

Activity

Follow suggestion No. 2 on page 36 of the unitext.

Study Problems and Exercises

1. Suppose you had never before seen or heard of an ant. How could you tell from its picture on page 6 that it is an insect? (*Six legs; three body regions; pair of antennas.*)

2. In what way which you cannot see from the pictures on page 6 are all insects alike? (*They all have an outside skeleton made of chitin.*)

3. What is the point of the pictures on pages 8 and 9? (*P. 4, ¶ 4*)

III. THE WORLD'S INSECT POPULATION (pages 4-6)

Core Ideas

There are more kinds of insects than of all other animals put together.

There are also tremendous numbers of most of the different kinds of insects.

The tremendous number of insects helps explain why insects are our greatest rivals.

Possible Approach

Let some member of the group stand in front of the class with outstretched arms to stand for all the kinds of animals in the world. Let the class find out, by reading the first paragraph of "The World's Insect Population" what part of his outstretched arms represents each of the big groups of animals in the world.

Activities

1. There are about a million known different kinds of animals in the world. Of these, 600,000 are insects. Plan and draw some kind of diagram to show what a large part of the animal kingdom is made up of insects.

2. Draw a square to stand for a square mile. Show in some way how the number of insects per square mile compares with the number of people. *(P.5, ¶2)*

Study Problems and Exercises

1. Show by some kind of diagram or graph how the number of kinds of insects compares with the number of kinds of mammals. *(P.5, ¶1)*

2. Why is the age in which we are living sometimes called the "Age of Insects" instead of the "Age of Man"? *(P.5, ¶2)*

IV. A PROBLEM WE MADE FOR OURSELVES (pages 6-10)

Core Ideas

Our insect enemies are becoming a more and more serious problem.

Man brought his troubles with insects upon himself by upsetting the balance in nature.

Possible Approach

Call the attention of the class to the heading of the section. Let them try to guess what this problem is before reading the section.

Activities

1. There is in this series of unitexts one called BALANCE IN NATURE. In it you can find other ways in which man has made trouble for himself by upsetting the balance in nature.

2. Draw a cartoon showing one thing man has done to bring his troubles with insects upon himself.

Study Problems and Exercises

1. What is the "problem we made for ourselves"? (*P.10, ¶3*)

2. What does "balance in nature" mean? (*P.6, ¶4*)

3. Tell in one short sentence how man has brought about a great increase in the number of insect pests. (*He has upset the balance in nature.*)

4. Tell any two of the ways in which man has brought about a big increase in the number of insect pests that harm wheat. (*P.9, ¶1*)

V. KINDS OF INSECT PESTS; VI. INSECT ENEMIES OF OUR FIELDS; VII. INSECT ENEMIES OF OUR GARDENS; VIII. INSECT ENEMIES OF OUR ORCHARDS; IX. INSECT ENEMIES OF OUR FORESTS; X. INSECT ENEMIES INSIDE OUR BUILDINGS; XI. CAUSERS AND CARRIERS OF DISEASE (pages 10-23)

Core Ideas

Some of our insect pests are natives of this country; others are foreign insects that have been brought into this country.

Some foreign insects, which are not pests in their native lands, are pests here because they have few natural enemies in this country.

Insects harm us in many different ways.

Our most dangerous insect enemies are those that carry disease.

Most insects do the harm that they do to us in trying to get the food they need.

Possible Approach

Call the attention of the class to the sketch on page 10. Ask what important point this little sketch is meant to bring out. Let them check by reading the first paragraph of "Kinds of Insect Pests."

Activities

1. Follow suggestion No. 5 on page 36 of the unitext.

2. Follow suggestion No. 8 on page 36 of the unitext.

3. Follow suggestion No. 9 on page 36 of the unitext.

4. Read about the grasshopper plague in *The Good Earth* by Pearl Buck.

5. Try to find pictures of insect pests that are not pictured in INSECT FRIENDS AND ENEMIES. Bring any you find to show to the class.

6. Give a report to the class about some insect pest which is not discussed in INSECT FRIENDS AND ENEMIES. You might, for example, give a report about the Japanese beetle. You can find out about this and other insect pests in encyclopedias and government bulletins.

Study Problems and Exercises

1. Divide a sheet of paper into three columns. Head the first column "Insects." Head the next column "Kind of Harm Done." Head the third column "Foreign or Native." In the first column write the names of all the insects shown in the colored pictures on pages 12 to 28. Read the first paragraph on page 29 and the last paragraph on page 33 to find which two of these insects are helpful insects. Cross these two off the list. Fill in the second column for each one of the 21 insects left in your list. Fill in the third column as fully as you can. You are not told whether all these insects are foreign or native.

2. How has man helped turn the grasshopper into a serious pest? *(P. 16, ¶ 3)*

3. Name any five of the ways in which insects hurt trees. *(P. 20, ¶ 1)*

4. Name any three diseases that are carried by insects. Tell what insect carries each of these diseases. *(P. 22, ¶¶ 5 and 6; p. 23, ¶¶ 1 and 2)*

XII. ERADICATION OR CONTROL? (pages 23-24)

Core Ideas

Control of insect pests is usually more practicable than eradication.

In carrying on a war against an insect pest, a person working alone cannot accomplish much—many people must work together.

One bureau of our government is in charge of the work of controlling insect pests.

Possible Approach

Call the attention of the class to the heading of the section. Ask them, before reading the section, to give their ideas of what the difference betwen the two terms is.

Study Problems and Exercises

1. Tell any one of the reasons why it is easier to control an insect pest than to get rid of it entirely. (*P. 24, ¶ 2*)

2. Why must the war against most insect pests be carried on by the government instead of by individual people? (*P. 24, ¶ 4*)

3. In the fight against the Mediterranean fruit fly, what two things were done which the fruit-growers probably would not have done if they had been left to fight the pest in their own ways? (*P. 24, ¶ 1*)

XIII. HOW MAN FIGHTS INSECTS (pages 26-30)

Core Ideas

There are four main ways of fighting insects—mechanical means, chemicals, quarantine, and biological control.

Different kinds of insects must be fought in different ways.

In fighting his insect enemies, man sometimes creates new problems for himself.

Possible Approach

The sketches on pages 24, 27, and 30 suggest three ways of fighting insect pests. Let the class try to tell, before reading the section, what those three ways are.

Activities

1. Follow suggestion No. 3 on page 36 of the unitext.

2. Follow suggestion No. 7 on page 36 of the unitext.

3. Read in *Hunger Fighters* by Paul De Kruif the story of the search for wheat which resists pests.

Study Problems and Exercises

1. Divide a sheet of paper into four columns. At the top of these columns write the four headings given in the first paragraph on page 26. Many ways of fighting insects are mentioned on pages 26, 27, 28, 29 and 30. Write on your paper under the proper heading each one of the ways mentioned.

2. What do you need to know about an insect before you can choose a chemical to use in fighting it? (*P. 27, ¶¶ 3 and 4*)

3. Under which of the four headings would you list a common fly-swatter? (*Mechanical means*)

4. What is the chief danger in bringing in a natural enemy of some foreign insect pest? (*P. 28, ¶ 3*)

XIV. INSECT FRIENDS (pages 31-35)

Core Ideas

Some insects furnish us with useful materials.

Some insects help us by killing insects that are harmful.

Some insects help us by eating dead plant and animal material.

Some insects help us by feeding on weeds.

Some insects are among our best flower-pollinators.

Scientists use insects in trying to solve some of the important problems about plants and animals.

Even insect pests may have helped us by showing that man cannot safely upset the balance in nature.

Possible Approach

Call the attention of the class to the picture on the cover of the unitext. Let them try to tell why this is an appropriate cover. (*The praying mantis is a friend; the grasshopper is an enemy.*) Ask them to check their ideas by reading the second paragraph on page 33 and rereading the third paragraph on page 15.

Activities

1. Follow suggestion No. 6 on page 36 of the unitext.

2. Hunt for pictures of insect friends not shown in the pictures in the unitext. Bring any you find to show to the class.

Study Problems and Exercises

1. Make a list of six general ways in which insects help us. The first one on your list might be: Furnish us with useful materials. (*See Core Ideas.*) After each way you have named, name at least one insect that helps us in that way.

2. How do the two insects in the pictures on page 29 help us? (*P. 33, ¶ 3*)

3. In the bodies of the insects shown in the pictures on page 29 there are often parasites that finally kill the insects. Are these parasites our friends or our enemies? (*Enemies, because they kill helpful insects.*)

XV. WILL THE INSECTS WIN? (page 36)

Core Idea

No one can yet tell what will be the outcome of our rivalry with insects.

Possible Approach

Call the attention of the class to the heading of the section. Ask why there should be any question of who will win. After a brief discussion, read the section with the class.

Activity

Make a list of 20 true statements about our insect friends and enemies. Change half of these to false statements. Use all the sets of statements all the members of the class make to play a true-false game just as a spelling match is played.

Study Problems and Exercises

1. How serious a problem is the problem of insect pests?
2. How would you answer the question in the heading of the section?

Materials and Equipment

(See page 405)

Pictures of animals, including 2 or more insects
BALANCE IN NATURE
Let the Hurricane Roar by Rose Wilder Lane
The Good Earth by Pearl Buck
Hunger Fighters by Paul De Kruif
White mulberry leaves
Silkworms or Cecropia moths 4
Small plant with plant lice on it
Several kinds of flowers

INSECT SOCIETIES

(Note general information page 5)

I. INTRODUCTION (pages 3-5)

Core Ideas

Mankind is social.

To be social means to be organized into societies in which there are both co-operation and division of labor.

The only animal societies which are like our own in showing both co-operation and division of labor are to be found among the insects.

The social insects have had a far longer history than social man.

Insect societies vary in size and complexity.

Possible Approach

Read to the class the first paragraph on page 3, omitting the final sentence. Lead the class to discuss whether they would like to live in such a community and where such a community could be found. Give them copies of INSECT SOCIETIES, and let them check their conclusion to the second question by reading on page 3 the last sentence of the first paragraph and paragraph 2. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activities

1. Draw a graph or diagram of some kind to show how much longer a history social insects have had than social man.

2. In an encyclopedia or some other reference book read about beaver colonies and the work they do. Be able to give a report to the class.

Study Problems and Exercises

1. Give one good reason for studying social insects. (*P. 5, ¶ 2*)

2. Tell two ways in which insect societies are like societies of people. (*Co-operation, division of labor*)

3. Mark each of the following sentences "True" or "False."

X (1) All animals are social.
X (2) All mammals are social.
X (3) All insects are social.
X (4) All social insects have very complex societies.
X (5) Societies of people are superior to societies of insects in every way.

II. WASPS (pages 5-9)

Core Ideas

Not all wasps are organized into societies; many kinds are solitary.

Among the social wasps we find queens, males, and workers.

Wasp societies vary in size and complexity.

In the cases of many social wasps there is division of labor during only a part of each year; during the winter and early spring the queens live solitary lives.

Possible Approach

Ask the class to recall the four stages in the life-history of a moth or butterfly with which they have had some experience. Call their attention to the pictures, on pages 4 and 5 of the unitext, of the ichneumon fly—an insect which has the same four stages in its life-history which moths and butterflies have. Have the class read the first five paragraphs of "Wasps" to find out why pictures of the ichneumon fly are given a place in a book about social insects.

Activity

Follow suggestion No. 1 on page 36 of the unitext.

Study Problems and Exercises

1. Start a chart which you will fill in as you progress through the unit. Divide a sheet into five columns, the first one at least three inches wide, the others narrow. At the tops of the narrow

columns write "Wasps," "Bees," "Ants," "Termites." In the wide column write these questions:

a) From what insects are they descended?

b) Are all kinds social?

c) How many stages are there in their life-histories? Fill in now the column headed "Wasps," and fill in the other columns later.

2. Start another similar chart. For this one you will need a wide column and eight narrow columns. Head the narrow columns "Social Wasps," "Bumblebees," "Honeybees," "Ponerine Ants," "Army Ants," "Fungus-growing Ants," "Dry-wood Termites," and "Common Termites." In the wide column write these questions:

a) Does the queen ever live a solitary life?

b) How many castes, or kinds of adults, are there in a society?

c) Are the workers male, female, or both?

d) How large are the colonies?

Fill in the blanks in the first column, and fill in the other columns as you read later about the other insects. You will not be able to answer the fourth question for all the eight groups.

3. Write captions, or titles, for the three pictures on page 6. (*P. 6, ¶ 4*)

4. Write captions for the three pictures on page 8. (*P. 8, ¶¶ 3 and 4*)

5. Tell one way in which co-operation is brought about in a wasp society. (*P. 7, ¶ 6*)

III. BEES (pages 9-16)

Core Ideas

Not all bees are organized into societies; there are still solitary bees.

Bumblebees are social insects, but their societies are rather simple.

Among bumblebees there is co-operation and division of labor during only a part of the year; the queens live solitary lives during the winter and early spring.

The honeybees are the most highly social bees.

The workers of a honeybee colony carry on many different kinds of activities.

Experiments have been carried on to show that ability to see color and to distinguish between different odors plays a part in the activities of honeybees.

All bee societies are made of queens, drones (males), and workers.

Among honeybees there is no time during which the queens live solitary lives.

Honeybees and flowering plants help each other.

Possible Approach

Ask the class to recall what solitary wasps eat. Let them read the first sentence of "Bees." Raise the question of whether there is anything surprising about the food of bees. Examine the picture on page 11 for signs that bees do not eat the same kind of food their wasp ancestors ate. Discuss the importance of the bees' change in diet to both the bees and the flowering plants, and let the class check their conclusions by reading the first four paragraphs of "Bees."

Activity

Follow suggestion No. 2 on page 36 of the unitext.

Study Problems and Exercises

1. Fill in the column headed "Bees" on the first chart.
2. Fill in the columns headed "Bumblebees" and "Honeybees" on the second chart.
3. Tell one mistaken idea the people of ancient times had about bees. (*P. 12, ¶ 4*)
4. Name eight activities you might see going on in a hive of honeybees. (*P. 13, ¶ 4*)
5. What do the experiments on pages 15 and 16 show? (*P. 15, ¶¶ 1-3; p. 16, ¶ 1*)
6. How does the food of some honeybee larvas differ from that of others? (*P. 14, ¶ 1*)

IV. ANTS (pages 16-24)

Core Ideas

All ants are organized into societies.

Ant societies differ greatly in complexity.

In all ant societies there are at least three castes; in some societies there are more.

Many ants are nomadic hunters.

Some ants have become agriculturists.

People have to learn to live with other people, to co-operate with them, and to carry on many activities. Ants, on the other hand, inherit their behavior.

Possible Approach

Reread with the class the description of a society of ants in the first paragraph on page 3. Ask what in the description shows that it is not a description of a hive of bees. (*Soldiers are mentioned.*) Ask whether one can conclude from this description that all ant societies have a soldier caste. (*No, insufficient data given.*) Have the class find by reading the first five paragraphs of "Ants" whether there is a soldier caste in all ant societies.

Activity

Follow suggestion No. 3 on page 36 of the unitext.

Study Problems and Exercises

1. Fill in the column headed "Ants" on your first chart.
2. Fill in the columns headed "Ponerine Ants," "Army Ants," and "Fungus-growing Ants" on your second chart.
3. Name any two of the surprising activities of army ants.
4. "An army of ants is very much like an army of our soldiers." Criticize this statement. (*P. 20, ¶¶ 1-2*)
5. Explain the sketch at the bottom of page 23. (*P. 21, ¶ 4*)
6. Tell one important difference between the lives of the army ants and those of the fungus-growing ants. (*P. 20, ¶ 3; p. 21, ¶¶ 2 and 3. Army ants are nomads; fungus-growing ants are farmers.*)
7. Tell very briefly the main ideas of the paragraph beginning near the bottom of page 23.

V. TERMITES (pages 25-31)

Core Ideas

All termites are organized into societies.

Some termite societies are very complex.

Termite societies, like the societies of other social insects, are huge families.

Some termites have become agriculturists.

Termites carry on many other rather complicated activities.

Termites inherit their behavior.

Improvement in termite societies is brought about by natural selection.

Possible Approach

Ask the class to tell of any experiences they may have had with termites. Tell the class that termites are often mistakenly called "white ants." What does this name suggest? (*That they look somewhat like ants.*) Call the attention of the class to the termite pictures on page 25. What similarity does this picture suggest between at least some termite societies and the more advanced ant societies? (*There are worker and soldier castes in both.*) Ask the class to read pages 25, 26, 27, 28, 29, and the first two paragraphs of page 30 to find other differences and similarities between ant and termite societies.

Activities

1. If you can take a trip to the woods, look in old tree stumps and in and under decaying logs for termites.
2. For more information about termites read *Termite City* by Emerson and Fish.
3. Look carefully at the picture on page 27. Be sure that you can pick out the king and queen. The queen is the big white "lump" in the center of the royal chamber. The king is at the side of the queen. His head shows dark against the queen's white body. The king, you see, is smaller than the queen.

Study Problems and Exercises

1. Fill in the column headed "Termites" on your first chart.
2. Fill in the columns headed "Dry-wood Termites" and "Common Termites" on your second chart.
3. What are protozoa? (*P. 25, ¶ 2*) What do they have to do with termites? (*P. 25, ¶¶ 3 and 4*)
4. Read the last paragraph on page 28. Suggest a reason why all the termites do not disappear in the parts of the world where there are anteaters. (*P. 28, ¶ 1*)
5. What is most amazing about the way the fungus-growing termites build nests and cultivate fungus? (*P. 30, ¶ 3*)
6. What improvement in the soldiers' way of fighting has natural selection brought about? (*P. 31, ¶ 1*)

VI. DOMESTICATED ANIMALS (pages 32-33)

Core Ideas

Some ants and termites have domesticated animals.

The domestication of animals among the ants and termites does not represent intelligent behavior.

All the domesticated animals of the ants and termites produce substances that attract ants and termites.

Possible Approach

Ask the class to try to explain the pictures on pages 31, 33, and 35. Let them check their explanations by reading the first three paragraphs of "Domesticated Animals."

Activities

1. Follow suggestion No. 4 on page 36 of the unitext.
2. Look at the picture on page 32. This picture shows two termites and a domesticated beetle, or termitophile. Notice that the beetle's abdomen is curved up over its back. This peculiar shape of the abdomen has probably been brought about in some way by living in termite nests.

Study Problems and Exercises

1. Explain "replete," "termitophile," and "myrmecophile." (*P. 32, ¶3; p.33, ¶¶1 and 2*)
2. Tell in your own words the main ideas of the last paragraph on page 33.

VII. INSECT AND HUMAN SOCIETIES (pages 34-36)

Core Ideas

There is much less conflict among insect societies than among societies of people.

The almost total absence of conflict comes from the fact that insects inherit their behavior.

Human beings must learn how to behave, but they can act wisely under many more sets of conditions than can insects.

The ability to learn many things is valuable only to an animal that lives a long time.

Because of the shortness of their lives, inherited behavior is better for insects than the ability to learn how to behave would be.

Living in societies has proved to be a very successful way of living.

Social insects and man live under more favorable conditions than do most animals.

In time man may develop social instincts without losing his ability to do a great many different kinds of things.

Possible Approach

Ask the class to tell ways in which insect societies are like human societies. Ask them to tell ways in which the two are different. Have them check by reading the first two paragraphs of "Insect and Human Societies."

Study Problems and Exercises

1. What explains the fact that there have to be teachers in societies of people? (*P. 34, ¶ 3*)
2. What explains the fact that there is much less quarreling and fighting in an insect society than in a society of people? (*P. 34, ¶¶ 3-5*)
3. What is the advantage of being able to learn how to do things instead of inheriting our behavior? (*P. 35, ¶ 1*)
4. Why is it better for the social insects to inherit their behavior than to have to learn how to do everything they do? (*P. 35, ¶ 2*)
5. Copy a sentence from page 36 which tells what we hope will happen in human societies. (*Next-to-last sentence in section*)

Materials and Equipment

(See page 405)

An abandoned hornets' nest
Demonstration beehive 4
Handbook of Nature Study by Anna Comstock
Termite City by Emerson and Fish
Materials for demonstration ant nest
Bees for beehive 4

KEEPING WELL

(Note general information page 5)

I. INTRODUCTION (pages 3-4)

Core Ideas

We expect our bodies to make adjustments to many different sets of conditions.

If they are to be able to adjust to changes, our bodies must be kept in good condition.

No one set of health rules is exactly right for everyone.

Possible Approach

Examine the pictures on pages 2 and 3 from the standpoint of what idea they are designed to illustrate. Check by reading the first three paragraphs of the section. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activities

1. Follow suggestion No. 4 on page 36 of the unitext.
2. Follow suggestion No. 5 on page 36 of the unitext.
3. Find and read accounts of explorers other than Byrd, and the hardships they encountered.

Study Problems and Exercises

1. What sentence on page 3 do the pictures on pages 2 and 3 illustrate? (¶ *3, sentence 2*)
2. In one sentence tell why it is important for a person to keep in good physical condition. (*P. 4,* ¶ *1*)
3. "George and John are the same age, so of course they need the same amount of food and sleep and exercise." Criticize this statement. (*P. 4,* ¶ *3*)

II. WHEN WE ARE WELL (pages 4-11)

Core Ideas

Our bodies are built of cells of many different kinds.

Growth and repair mean the building of new cells from materials supplied by food.

Metabolism goes on in all living things.

Metabolism includes the building up of food materials into new living material and the tearing down of food or of living material to furnish energy.

The basic metabolic rate is almost the same for all individuals of the same race, age, sex, height, and weight.

The basic metabolic rate is controlled partly by a substance produced by the thyroid gland.

Body temperature is another physiological constant.

Body temperature is regulated by dilation and contraction of surface blood vessels, by change in rate of muscle action, and by change in rate of perspiration.

The chemical composition of body fluid is a third physiological constant.

Possible Approach

Discuss ways in which all the members of the group, when well, are alike. From a quick survey of the section find additional points to add to the list.

Activities

1. Follow suggestion No. 2 on page 36 of the unitext.
2. Follow suggestion No. 3 on page 36 of the unitext.
3. Follow suggestion No. 13 on page 36 of the unitext.
4. Look at prepared slides of cells under the microscope.
5. Burn several kinds of food by putting small pieces on a wire screen or a sheet of metal over a Bunsen burner. Note that some foods burn faster and more completely than others.
6. Find among the chemicals in your science room compounds of as many as you can of the elements listed in the last paragraph on page 10.

Study Problems and Exercises

1. What do the pictures on pages 4 and 5 show? (*P. 4, ¶ 4*)

2. The process of metabolism does two things in our bodies. What are they? (*P. 5, ¶¶ 4 and 5*)

3. In what two ways is metabolism like a campfire? (*Fuel is burned; wastes are produced.*)

4. In the following sentence what is being described? It is the rate at which burning goes on in your body when you are lying still after having had no strenuous exercise for at least half an hour, when your surroundings are comfortably warm, and when you have had no food for at least twelve hours. (*Basal metabolic rate*)

5. In the list below underline those which have to do with regulating body temperature.

muscle action
sweating
secretion of digestive juice
shivering
dilating of blood vessels
thinking

6. Pages 3 to 11 tell of three ways in which all normal people are alike. What are they? (*Basal metabolic rate; body temperature; chemical make-up.*)

7. What does the thyroid gland have to do with the basal metabolic rate? (*P. 7, ¶ 3*)

8. Fill in the following blanks:

Our normal temperature is *(37°)* on the centigrade scale.
Our normal temperature is *(98.6°)* on the Fahrenheit scale.
All living things are made up of *(cells)*.
The chemicals in our body are kept in balance by means of *(buffers)*.
New body cells are made when older cells *(divide)*.

III. Doing Your Share (pages 11-12)

Core Ideas

Doing one's share includes having regular check-ups by doctor and dentist.

Doing one's share also includes working out good health rules and following them.

Possible Approach

Call attention to the heading of the section. Ask of what the group thinks doing one's share would consist. Check by glancing through the section rapidly.

Activities

1. Follow suggestion No. 10 on page 36 of the unitext.

2. Find out from your doctor, dentist, and oculist how often in their opinion a person your age should have a check-up.

3. If you wear glasses, find out from your oculist what fault they are designed to correct.

4. Make a list of the medicines you hear advertised over the radio in the course of some week.

5. Cut out advertisements for patent medicines from newspapers.

6. Find out from reference books what the Pure Food and Drugs Administration does to protect you against medicines that might be harmful.

Study Problems and Exercises

1. Doing your share means which of the following things?

_____ If you suffer regularly from indigestion, select one of the best medicines advertised on the radio.

_____ Wait until a cavity gets fairly large before seeing a dentist.

__√__ If your eyes feel strained from reading, consult an oculist without delay.

__√__ See a doctor if you are losing weight or if your temperature is not normal.

__√__ Work out good health rules for yourself and follow them every day.

2. Make titles for the pictures on pages 10 and 12. (*An Old-Time Medicine Show; Consulting Your Doctor*)

3. What point are the two pictures meant to emphasize? (*P. 11,* ¶ *4*)

4. Name one good health habit you have formed.

IV. Food (pages 13-16)

Core Ideas

Food is needed to furnish energy, to furnish building material, and to regulate body processes.

Our diets should be well balanced so that we get an ample supply of all the nutrients: proteins, carbohydrates, vitamins, fats, minerals, and water.

Our diets should include some roughage as well as the needed nutrients.

Foods cannot serve their purpose in our bodies unless they are digested; keeping well includes keeping our digestive systems in good order.

Possible Approach

Have a day's meals set up with food models. Ask the class to give their ideas as to whether the meals set up constitute a good day's menu for a teen-age person. Direct the discussion toward the criteria of a good diet. Let the class refer to the text for points to be considered.

Activities

1. Follow suggestion No. 11 on page 36 of the unitext.
2. Follow suggestion No. 12 on page 36 of the unitext.
3. Carry out as many as possible of the suggestions on page 36 of the unitext FOODS.
4. From the calorie chart on page 7 of FOODS find out how many calories you need per day.
5. Find out from the unitext HOW WE ARE BUILT and from other biology books how the foods you eat are digested.

Study Problems and Exercises

1. For what four reasons do we need food? (*P. 13, ¶ 1*)
2. Write a good definition for "calories." (*P. 13, ¶ 2*)
3. Fill in the blank space with the name of the nutrient that is being described.

*(Minerals)*________ They furnish no energy, but are needed for growth and repair and for making the body run as it should.

(Carbohydrates)	They furnish energy and are found in potatoes, cereals, candy, fruits, and many other foods.
(Water)	It furnishes no energy or building materials, but without it food cannot get into the blood and wastes cannot get into the kidneys.
(Proteins)	They can furnish energy, but are used chiefly to make new cells.
(Vitamins)	A lack of a tiny amount of these may cause disease. They help keep us well.
(Fats)	They furnish excellent fuel. Some of the best sources are butter, cream, and salad dressing.

4. Mark these sentences true or false.

X (1) If we eat large quantities of food, we are sure to get all the food materials we need to be healthy.
C (2) The number of calories a person needs depends on his age, sex, weight, and occupation.
C (3) Iodine helps to prevent goiter.
X (4) Foods classified as roughage should never be eaten.
X (5) It is always harmful to eat between meals.
C (6) It is a good idea not to eat when you are very tired, excited, worried, or angry.

V. Fresh Air; VI. Sunshine (pages 17-19)

Core Ideas

Oxygen is necessary for metabolism.

Getting plenty of fresh air is an important element in keeping well.

Sunshine helps us keep well because it enables our bodies to build up vitamin D and because it is a powerful germ-killer.

Too long an exposure to bright sunshine may be harmful.

Possible Approach

Discuss the classroom in which the class is meeting from the standpoint of the provisions made for fresh air and light.

Activities

1. Breathe through a glass tube into limewater and note the effect on the limewater. Carbon dioxide turns limewater milky.

2. Wring two cloths the same size out of water. Hang one in open air to dry; hang the other indoors in some place where the air is not circulating freely. Note how the speed with which they dry compares.

3. Wrap the bulbs of two thermometers in bits of cotton cloth, one dry and one wet. Hang them in circulating air and note the readings after a few minutes.

4. From some biology textbook find out how to prepare bacteria cultures. Prepare two. Place one in the dark and the other in bright sunshine. After a day or so note any differences between the two.

Study Problems and Exercises

1. List five good reasons for spending much time out of doors. (*P. 18, ¶ 4; p. 19, ¶ 1*)

2. "The longer you stay in the sunshine, the better it is for you." Criticize this statement. (*P. 19, ¶ 4*)

VII. Exercise and Good Posture (pages 20-21)

Core Ideas

Exercise is a help in keeping well, but care must be taken not to strain muscles.

Exercise strengthens muscles.

Strong muscles are a help in good posture, which in turn is a help in keeping well.

Possible Approach

Figure out how much of their school time the members of the group give to physical education. Raise the question of how giving a large percentage of the school day to physical education can be justified. Check by reading the first paragraph of the section.

Activities

1. Take your pulse. Then run or engage in some other active exercise for a brief period of time. Again take your pulse.

2. Count the number of times you breathe per minute. Then run or engage in some other active exercise for a brief period of time. Again count the number of times you breathe per minute.

3. Examine a posture chart. Get the opinion of others in your class about your posture.

Study Problems and Exercises

1. This section on "Exercise and Good Posture" tells you that exercise speeds up your breathing and your circulation. Tell why this increased action should make you feel better. (*P. 20,* ¶ *1*)

2. For what two main reasons should you work for good posture? (*P. 21,* ¶¶ *2 and 3*)

VIII. REST AND SLEEP (pages 22-24)

Core Ideas

Rest and sleep afford the body a chance to rid itself of accumulated wastes.

Change of activity is at times as restful as inactivity; sleep, however, is the best form of rest so far as repairing the damage done by fatigue is concerned.

Individuals differ as to the exact number of hours of sleep they require.

Possible Approach

Point out that in many cases getting enough rest presents far more of a problem than getting enough exercise. Raise the question of why rest is necessary. Check the suggestions offered by reading the first three paragraphs of the section.

Activities

1. Find some set of training rules for athletes. Notice what the rules say about rest and sleep.

2. The chart on page 24 of the unitext tells how much sleep the average person your age needs. Experiment to find out whether this is the right amount of sleep for you.

Study Problems and Exercises

1. What causes fatigue? (*P. 22, ¶ 1*)

2. List three important reasons why we should have plenty of rest and sleep. (*P. 22, ¶¶ 2 and 3*)

3. What did the experiment described on page 23 show? (*P. 23, ¶ 3*)

4. Does the diagram on page 24 tell you how many hours of sleep you should get every night? Explain your answer. (*P. 24, ¶ 2*)

5. What sentence in the section is the picture on page 23 meant to illustrate? (*P. 23, ¶ 1, sentence 2*)

IX. CLOTHING (page 25)

Core Ideas

To be healthful clothing should be suitable for the weather at hand and should not be too tight.

Well-fitting shoes are an important help in keeping well.

Possible Approach

Call attention to the pictures on pages 18 and 19 and ask in which picture, if in either, the boys and girls are better dressed from the standpoint of health. Raise the question of what the criteria are for judging the healthfulness of one's clothing. Check by scanning the section.

Activities

1. Fill two similar containers full of hot water. The water should be the same temperature in each. Wrap one with a wool cloth and the other with a loosely woven cotton cloth. Stand the two containers side by side in a cool place. Take the temperature again after fifteen minutes.

2. Collect pictures showing fashions of early times. From the standpoint of healthfulness, compare earlier fashions with those of today.

3. Collect pictures of footwear from various parts of the world.

Study Problems and Exercises

1. What three criteria of healthful summer clothing do the clothes of the boy and girl shown in the picture on page 22 meet? (*Allow perspiration to evaporate, do not shut in heat, and are loose.*)

2. Tell one reason why the costume worn by the girl in the picture on page 25 is not healthful. (*P. 25, ¶ 2*)

X. KEEPING WELL GROOMED (pages 26-27)

Core Ideas

Keeping clean and well groomed not only helps make one attractive but also makes for good health.

For most people mild soap is the best cleansing agent.

Teeth, hair, and nails need special care.

Possible Approach

Call attention to the title of the section. Ask the class whether they think good grooming important and, if so, why. Let them check their conclusions with the reasons given in the first paragraph on page 26.

Activities

1. From reference books get additional information about the causes and prevention of pimples.

2. Examine the diagram on page 34 of HOW WE ARE BUILT to see how complicated the skin is.

3. Make a chart by which you could rate yourself and others in your group on grooming.

Study Problems and Exercises

1. Mark these sentences true or false:

X (1) Being well groomed simply means wearing good clothes.
C (2) Clogged up ducts of oil and sweat glands may cause pimples.
X (3) Deodorants should never be used.
X (4) Hair should never be washed more frequently than every two weeks.
C (5) Keeping feet clean and dry will help prevent "athlete's foot."

2. Give two reasons for giving yourself manicures regularly. (*P. 27, ¶ 3*)

XI. Disease Germs—Threats to Our Health
(pages 28-30)

Core Ideas

Many diseases are caused by germs.

Some disease germs are bacteria; some are protozoa; some are viruses.

Disease germs may make us ill by destroying cells of the body; they may make us ill by producing poisons, or toxins.

Some germ diseases are contagious.

Our bodies have two chief ways of fighting disease germs: destroying them with white blood cells, and producing chemicals to counteract the toxins produced by the germs.

Keeping our bodies in good condition makes us more resistant to disease germs.

Having certain diseases once makes us immune to them.

Possible Approach

Call attention to the heading of the section. Raise the question of what we mean by disease germs. Check the ideas presented by reading the first five paragraphs of the section.

Activities

1. Follow suggestion No. 6 on page 36 of the unitext.
2. Follow suggestion No. 7 on page 36 of the unitext.
3. Follow suggestion No. 9 on page 36 of the unitext.
4. Follow suggestion No. 15 on page 36 of the unitext.
5. Find and read the story of Leeuwenhoek and the microscope.

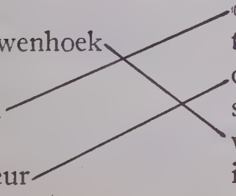
Study Problems and Exercises

1. Match these parts of sentences.

Leeuwenhoek

Koch

Pasteur

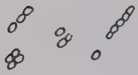


discovered the cause of anthrax and tuberculosis.

discovered the cause of disease among silkworms.

was the first to see microscopic organisms.

2. The bacteria pictured belong to three different groups. Name the group to which each kind belongs.



(Cocci)

(Bacilli)

(Spirilla)

3. Fill in this table:

Kind of Disease Germ	Plant, Animal, or Neither	Two Diseases They Cause
Bacteria	*(Plant)*	*(Pneumonia)*
		(Diphtheria)
Protozoa	*(Animal)*	*(Malaria)*
		(Amebic dysentery)
Viruses	*(Neither)*	*(Smallpox)*
		(Infantile paralysis)

4. Tell two ways in which germs cause disease. *(P. 29, ¶ 6)*

5. List four ways in which disease can be carried from person to person. *(P. 29, ¶ 7)*

6. What does the term "contagious disease" mean? *(P. 29, ¶ 7)*

7. What is being described in each of these two short paragraphs?

They can move out through walls of blood vessels. They can destroy germs. Pus is largely made up of them. *(White blood cells)*

They are made by the body immediately after germs enter. They counteract the poisons produced by germs. (*Antitoxins*)

8. Fill in these two columns:

Examples of Diseases to Which We Can Become Immune	*Examples of Diseases to Which We Do Not Become Immune*
1)____________________	1)____________________
2)____________________	2)____________________
3)____________________	3)____________________

9. John Doe was exposed to mumps yesterday. Assuming that he is not immune to mumps, name at least four factors on which his catching the disease will depend. (*P. 30, ¶ 4*)

10. Explain the picture on page 33. (*P. 30, ¶ 2*)

XII. Avoiding and Conquering Germs (pages 31-33)

Core Ideas

There are many simple precautions that can and should be taken to avoid disease germs.

Aseptic surgery represents an important forward step in surgery.

Ways have been found of making a person immune to various germ diseases.

Ways have also been found of helping a person overcome a germ disease he has contracted.

Possible Approach

Discuss the precautions the school takes to prevent the spread of communicable diseases. Then discuss each individual's responsibility in the matter. Check by reading the first seven paragraphs of the section.

Activities

1. Follow suggestion No. 1 on page 36 of the unitext.
2. Follow suggestion No. 8 on page 36 of the unitext.

3. Follow suggestion No. 14 on page 36 of the unitext.

4. From reference books find out about the tests that are used to determine whether a person is immune to scarlet fever, diphtheria, and various other diseases.

5. Make a survey of some group of adults to find out against what diseases they have been immunized.

6. Make a similar survey of the members of your class.

7. Find out from the unitext Water Supply how city water supplies are made safe.

8. From the unitext Community Health find out how cities protect their people from communicable diseases.

Study Problems and Exercises

1. Pages 31 and 32 tell of five ways in which disease germs can be avoided. List the five ways.

2. Page 33 tells of several ways in which our bodies can be helped to fight disease germs. List them.

3. Fill in the following blanks:

One of the first physicians to recognize the need of cleanliness in hospitals was *(Semmelweiss)*.

One of the first chemicals Lister used to prevent infection after operations was *(carbolic acid)*.

Lister will always be remembered for his work in establishing modern *(aseptic)* surgery.

It was *(Pasteur)* who discovered how to immunize against disease.

XIII. First Aid (pages 34-35)

Core Ideas

Everyone should know some simple first aid rules.

How rapidly a person will recover from an accident depends largely on his general health.

Possible Approach

Read the first paragraph of this section. Then examine the pictures on pages 34 and 35 and from them make a list of rules for avoiding the need for first aid.

Activities

1. Examine the *American Red Cross First Aid Textbook*. Practice some of the kinds of bandages described in it.

2. Find and read the report put out by the National Safety Council entitled *Accident Facts*.

3. For information on accident prevention examine the booklet *Home and Farm Accident Prevention*, put out by the American Red Cross.

4. Collect for a week newspaper clippings about accidents. From the accidents you and other members of your group report, make a graph showing how accidents from various causes compare in number.

Study Problems and Exercises

1. Check the best answer for each of the following:

1) If a person has been injured in an automobile accident,
    _____ move him immediately to a comfortable bed if possible.
    __√__ let him lie where he is, if possible, until the doctor comes.
    _____ carry him, if possible, to the nearest doctor.

2) For an extensive burn,
    __√__ do nothing until the doctor comes.
    _____ apply oil or cold cream immediately.
    _____ ask your druggist to recommend a good remedy.

3) For minor cuts or skinned places,
    _____ apply iodine half-strength and bandage with a sterile cloth.
    __√__ wash well with soap and water, apply mild disinfectant, and bandage with a sterile cloth.
    _____ do nothing at all.

4) The best rule about first aid is:
    _____ Always carry a first aid kit.
    __√__ Be careful to avoid injury.
    _____ If hurt, ask advice from onlookers.

2. On what two things does a person's recovery from an injury depend? (*P. 35, ¶ 6*)

Materials and Equipment

(See page 405)

Fever thermometer 3, 4
Prepared slides of cells, blood, and disease germs 4
Bunsen burner 4
Wire screen or sheet of metal 4
Food models
Glass tube 4
Test tube 4
Limewater 4
2 chemical thermometers 4
Cotton cloth for wrapping bulbs
Posture chart 4
2 large pieces of fabric, 1 woolen, 1 loosely-woven cotton

Readers Digest, February, 1939
FOODS
HOW WE ARE BUILT
THE FIGHT AGAINST GERMS
WATER SUPPLY
COMMUNITY HEALTH
American Red Cross First Aid Textbook
Accident Facts (National Safety Council)
Home and Farm Accident Prevention (American Red Cross)

LIFE THROUGH THE AGES

(Note general information page 5)

I. WHEN THE WORLD WAS YOUNG (page 3)

Core Ideas

There was a time when there were no living things on the earth.

The first living things must have been very small.

The first living things must have been able to make their own food, much as green plants do now.

All the living things of today have come from the first simple living things.

Possible Approach

Ask the class to guess how many kinds of plants and animals there are in the world today. Then tell them the correct numbers (*about 1,000,000 kinds—species—of animals, and about 250,000 species of plants*). Next raise and discuss these questions: Have the same kinds of plants and animals that live on the earth now always lived here? Have there always been plants and animals on the earth? After a discussion of these questions, give the class copies of LIFE THROUGH THE AGES and let them check their answers by reading the first three paragraphs of the section. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activities

1. Examine some one-celled green algae with a microscope.
2. Follow suggestion No. 4 on page 36 of the unitext.
3. In BALANCE IN NATURE, another unitext in this series, read pages 10-14. Examine the pictures and diagrams of food-chains on pages 14, 15, 16, 17, 19, and on the inside back cover. Notice that

each food-chain begins with a plant of some kind.

Study Problems and Exercises

1. There are five paragraphs on page 3. Give in a sentence the main idea of each paragraph.

2. Why are we sure that the first living things on the earth could not have been tigers? (*P. 3, ¶ 4*)

II. How We Know (pages 4-5)

Core Ideas

All we know about the plants and animals on the earth before men learned to keep records has been learned from fossils.

Fossils are remains or traces of plants and animals of long ago.

There are many different kinds of fossils.

The greatest store of fossils is in water-made rocks.

Scientists have divided the history of the earth into eras and periods.

Possible Approach

Call the attention of the class to the picture on page 2. Tell them that this animal appeared, flourished, and disappeared long before people were able to keep records—in fact, millions of years before there were any people on the earth at all. How do we know that they ever existed? Let the class check its suggestions by reading the first paragraph of the section. Before asking them to read further, show some fossils of different kinds.

Activities

1. Follow suggestion No. 1 on page 36 of the unitext.
2. Follow suggestion No. 2 on page 36 of the unitext.
3. Follow suggestion No. 5 on page 36 of the unitext.
4. Follow suggestion No. 6 on page 36 of the unitext.
5. If there is a museum near you, perhaps you can find there a large piece of rock containing many fossil bones. Seeing such a piece of rock will help you understand that getting fossil bones from rocks is not easy.
6. Make a model of a section of the earth's crust by piling up layers of modeling clay of different colors, one on top of the other. Carve out of soap some small models of fossils. Push these into the edges of the layers of clay. Be sure to put the models of the oldest fossils in the bottom layer of rock. The chart on the inside

cover of Animals of Yesterday, another unitext in this series, will be helpful.

7. Cut a strip of paper 6 in. wide and 4 ft. long. Beginning at one end, mark off the Cenozoic, Mesozoic, and Paleozoic eras just as they are on the inside front cover. This chart is drawn on a scale of 1 in. to 80,000,000 years. Notice that there was not enough room on the inside cover to draw the earlier eras to scale. On your long strip of paper you can do so. The Proterozoic era should be 15 in. long, the Archaeozoic 10 in. long, and the Azoic 12½ in. long. This chart should help you see that the Age of Mammals is a very small part of the earth's long history.

Study Problems and Exercises

1. Underline the fossils in the list below:

A bone of a horse of today
A cast of a snail of long ago
A mounted moth
A petrified tree trunk
A footprint of an ancient reptile
A pressed leaf

2. In what kinds of rocks are most of the traces of the plants and animals of long ago found? (*P. 5, ¶¶ 2-3*)

3. Which one of the periods shown in the chart on the inside front cover was longest? (*Cambrian*)

4. Underline the kinds of plants and animals in the list below that are known to have been on the earth during the period you named as the answer to Exercise 3.

sponges
ferns
worms
birds
flowering plants
algae
mammals
insects
corals

III. The Heyday of Animals without Backbones (pages 6-7)

Core Ideas

For millions of years after the first animals appeared, no animals had backbones.

For a very long time all the animals lived in the sea.

First one group of animals without backbones and then another ruled the seas.

Many kinds of animals that were very successful during the heyday of animals without backbones have become extinct.

Even today there are many more kinds of animals without backbones than with backbones.

Possible Approach

Call attention on the chart on the inside front cover to the word "invertebrates." Explain what it means if no one in the class can do so. List on the board the five big groups of animals with backbones (*fishes, amphibians, birds, reptiles, mammals*). Let the class find from the chart whether any of these animals was present at the beginning of the Age of Invertebrates. Does the chart show that "Age of Invertebrates" is a good name for the three periods it includes? Let the class now find from the chart the name of a group of invertebrates that was present during the Age of Invertebrates but later completely died out. (*Trilobites*) Direct them to the first four paragraphs of the section as a means of finding out some of the characteristics of trilobites and how important these animals were in early times.

Activities

1. Make a collection of pictures of animals of today that live in the sea and do not have backbones.

2. Look at the pictures in ANIMALS OF THE SEASHORE, another unitext in this series. In this booklet you will find pictures of the squid and the chambered nautilus (cephalopods), the horseshoe crab (a close relative of the trilobites), the sea lily (a crinoid), sea snails (gastropods), coral, sea worms, clams, and starfishes.

3. Many of the specimens in a fossil collection are almost sure to be fossils of animals without backbones. Look for fossils of animals without backbones if you visit a museum to see its fossil collection.

Study Problems and Exercises

1. Mark each of the following sentences "True" or "False."

C (1) So far as we know, all the animals of the early Paleozoic lived in the sea.

C (2) The trilobites were once the largest and most intelligent animals on earth.

C (3) The trilobites became extinct millions of years ago.

X (4) The animals without backbones are now greatly outnumbered by the animals with backbones.

X (5) We are sure that fossils have now been found of all the animals that lived long ago.

2. Underline the animals in the list below that are represented in the pictures on pages 6 and 7.

sea lily
trilobite
gastropod
cephalopod
coral
clam
brachiopod
sea worm
sponge

IV. How Changes Are Brought About (pages 8-9)

Core Ideas

Among living things there is a struggle for existence which has played a part in the development of the living things of today from the first simple living things.

All kinds of living things show variations, some of which can be passed on from generation to generation.

Some variations are helpful; some are harmful.

Hereditary variations have played a very important part in the development of the living things of today from those of long ago.

Helpful hereditary variations are saved by natural selection.

In the course of hundreds of generations, changes may pile up so that a new kind of plant or animal is produced.

The plants and animals that have given rise to the higher plants and animals did not plan in any way that their descendants would be different from themselves.

Possible Approach

Point out that there were thousands of different kinds of animals in the Age of Invertebrates, and that they all came from the first simple animals. Lead the class to raise the question of how such changes were brought about. Then, since this section is the most difficult in the book, read with the class all but the final paragraph of the section. Discuss each paragraph to be sure that the meaning is clear. Carry on at appropriate places in the discussion the activities suggested.

Activities

1. A common shrimp lives only a year. During its lifetime, a female shrimp lays 500,000 eggs. Suppose that all the eggs one female shrimp lays hatch, that all the young shrimps live to become adults, and that half of each generation are females. Find out how

many descendants of the one shrimp there would be in five years. (*1,953,125,000,000,000,000,000,000,000*)

2. From page 33 of INSECTS AND THEIR WAYS, another unitext in this series, find out how rapidly flies multiply.

3. Read on page 10 of *Science News Letter* for July 4, 1942, about the enormous number of paramecia produced in five years from a single paramecium.

4. Get six beans, all of the same kind. Plant them in six different pots filled with the same kind of soil. Keep the pots close together in the sunshine so that conditions for all the young plants will be as nearly the same as you can make them. Give all the pots the same amount of water each day. Look for variations among the young plants. Are any two of them exactly alike?

5. Look at a litter of kittens, puppies, or pigs, or at a picture of such a litter. Look for variations among the young animals in the litter.

Study Problems and Exercises

1. One of the following accounts illustrates struggle for existence; one illustrates hereditary variations; and one illustrates natural selection. Which illustrates which?

(a) Some years ago a farmer who was walking past a field of lima bean vines growing on tall poles saw a dwarf plant growing at the edge of the field. It was a bush, not a vine, although it had come from the seed of a vine. No one had heard of a bush lima bean before this time. The farmer gathered some of the beans from this plant and planted them. They grew into dwarf plants. So did the beans these plants produced. Thus a dwarf variety of lima bean was established. (*Hereditary variation*)

(b) A small hollow under an oak tree was filled in the fall with acorns. In the spring all these acorns sprouted. They all sent their roots down into the ground. One of the young oak trees had longer, stronger roots than the others. This oak tree was the only one of the group that lived through the hot, dry summer weather. (*Natural selection*)

(c) On the average, only two of the shrimps that hatch from the 500,000 eggs laid by an adult female shrimp escape all their enemies and live to become full-grown shrimps. (*Struggle for existence*)

2. "Some of the kinds of animals that flourished in the heyday

of animals without backbones have lived on for the millions of years since that time with little change. But some of them were clever enough to change into much larger and more powerful animals." What is wrong with this paragraph? (*P. 9, ¶ 3*)

V. THE COMING OF THE FISHES (pages 10-11)

Core Ideas

The first animals with backbones were fishes.

For a long time the fishes were the rulers of the animal world.

Most of the early fishes were very different from those of today.

Possible Approach

Ask the class to find out from the chart on the inside front cover which one of the big groups of animals with backbones first appeared. (*Fishes*) Let the class tell how the fishes of today can be told from other animals. (See "What Is a Fish," in FISHES, another unitext in this series.) Show a picture of a yellow perch, a typical fish of today (page 8 of FISHES). Explain that it is a ray-finned fish. Let the class find by reading whether the first fishes were like those of today.

Activities

1. The picture on page 9 shows an ancient shark. Notice that the picture of the shark is one-tenth actual size. Measure off on the blackboard the real length of this fish.

2. Find in other books pictures of other ancient fishes.

3. In FISHES look at the picture of the sturgeon (page 22). The sturgeon is one of the few armored fishes of today.

4. Sharks' teeth are rather common fossils. Look for them and for skeletons of ancient fishes if you visit a fossil collection.

5. Find a picture of a lungfish of today.

6. On page 17 of ANIMALS OF YESTERDAY find a picture of Dinichthys.

Study Problems and Exercises

1. Is the color of the shark in the picture on page 9 accurate? Explain your answer. (*P. 10, ¶ 6*)

2. Why should the lungfishes of today be called "living fossils"? (*P. 11, ¶ 2*)

3. What question about the first fishes can no one answer? (*P. 10, ¶ 2*)

4. For how long a time, according to the chart on the inside front cover, were the fishes the rulers of the animal world? (*35 million years*)

VI. The Invasion of the Land (pages 11-13)

Core Ideas

The first land plant was probably a liverwort.

The first land animal was probably a scorpion.

The first land animals with backbones were amphibians.

Amphibians begin their lives in water, but later most of them become air-breathing animals and can live on land.

The amphibians came from the fishes.

Possible Approach

Call attention to the fact that all the animals discussed in "The Heyday of Animals without Backbones" and "The Coming of the Fishes" lived in the sea. Let the class try to tell from the chart on the inside front cover what land-living invertebrates first appeared, and what animals with backbones first lived on land. Let them check their ideas by reading the fourth and last paragraphs on page 12. Then let them find out by reading further what the first land plant is supposed to have been.

Activities

1. Examine with a microscope as many different kinds of algae, fungi, and bacteria as you can.

2. Get a liverwort and examine it.

3. Look at the pictures in Toads and Frogs, another unitext in this series. These pictures show some of the amphibians of today.

4. Make a collection of pictures of amphibians of today.

5. From reference books find out all that you can about modern scorpions.

Study Problems and Exercises

1. Match these parts of sentences:

Eryops was	a scorpion.
The first land plant was probably	an amphibian.
Paleophonus was	a liverwort.

2. Why were the early liverworts very important in the history of plants? (*P. 12, ¶ 3*)

3 Calling the first amphibian "the fish that walked" suggests

what belief of scientists about this animal? (*P. 13, ¶ 1*)

4. A well-known poem tells about a fish and a tadpole that swam about in the Cambrian seas. What is wrong? (*Tadpoles are young amphibians. There were no amphibians or fish in the Cambrian.*)

VII. PLANTS THAT TURNED TO COAL (pages 13-14)

Core Ideas

Coal was made from plants, chiefly from trees.

Most of the trees in the forests of the Coal Age were not seed plants.

The trees of the Coal Age were descendants of the liverworts.

Possible Approach

Show the class a lump of coal, and let someone identify it. Tell the class that coal is sometimes called "buried sunshine," and let them try to explain why this name is appropriate. Have them check their ideas by reading the first four paragraphs of the section. Remind them that trees cannot grow without sunshine.

Activities

1. Examine pictures or specimens of club mosses and horsetails of today.

2. Find pictures of tree ferns. If there is a large conservatory near you, perhaps you can see some living tree ferns in it.

3. Draw a set of six diagrams to tell the story of how coal was made. The first diagram should show trees growing in a swamp. The second should show the trees in the swamp covered with water. From your reading you can find what the other diagrams should show.

4. Examine the chart "When Was Coal Formed?" Notice especially the part of the chart that tells what plants went into the making of coal during the Coal Age. This chart may be obtained from the Museum of Science and Industry, Chicago, Ill.

5. Look for spores on fern leaves. Examine with a microscope any you find.

Study Problems and Exercises

1. Underline in the list below the kinds of plants that lived during the Great Coal Age. Put a *C* after those that formed the forests from which coal was made. Consult both the book and the chart on the inside front cover.

elms
horsetails *C*
algae
spruces
ferns *C*
pines
fungi
seed ferns *C*
liverworts
club mosses *C*
bacteria
roses

2. Fill the blank in this sentence: The plant pictured on page 14 is a *(club moss)* .

3. What, so far as we know, were the first seed plants to appear on the earth? (*P. 14, ¶ 4*)

4. If you were trying to find out for yourself whether any coal is being made today, to what kind of region would you go? (*Swampy region*)

VIII. A Who's Who of the Dinosaurs; IX. Reptiles That Swam and Flew (pages 15-20)

Core Ideas

The first truly land animals were reptiles.

The reptiles were so successful that they soon were the dominant animals.

For many millions of years the reptiles ruled the earth.

Among the reptiles that lived during the Age of Reptiles there were many dinosaurs.

Some of the dinosaurs were the largest land animals that have ever lived.

The dinosaurs had small brains in proportion to their size.

Changes in climate helped bring about an end to the dinosaurs.

No one knows surely why all the dinosaurs disappeared.

During the Age of Reptiles there were many reptiles that lived in the sea and many that flew through the air.

These reptiles were descendants of the early land reptiles.

The flying reptiles and the fish lizards disappeared completely.

Possible Approach

Ask the class to find out from the chart on the inside front cover what age followed the Coal Age, and how long this age lasted. Then ask them to look at the chart on the inside back cover. Lead them to discover that, of the nine groups of reptiles shown on the chart, four became extinct at the end of the Age of Reptiles. Refer them to the text to find out about these four groups that became extinct.

Activities

1. In Animals of Yesterday there are pictures of some ancient reptiles not shown in this book. Look at them.

2. Make for the bulletin board a collection of pictures of ancient reptiles.

3. Make a diorama showing a scene in the Age of Reptiles.

4. Measure off on the floor of the school corridor the real lengths of the reptiles shown in the pictures on pages 2, 15, 17, and 19.

5. Look at the pictures in Reptiles, another unitext in this series. In this book there are many pictures of reptiles of today.

6. In Reptiles read about the tuatara, a so-called "living fossil."

7. For fun read "The Dinosaur," the jingle mentioned on page 16. It was written by Bert Leston Taylor and was first published in *A Line-o'-Verse or Two* in 1914.

Study Problems and Exercises

1. *Eryops* (page 11) was not a true land animal; *Allosaurus* (page 15) was. What important difference is there between their life-histories?

2. Mark each of the following sentences "True" or "False."

X (1) All dinosaurs were huge.
X (2) All dinosaurs were meat eaters.
X (3) All dinosaurs had large brains.
X (4) We can tell a great deal about the ancient dinosaurs by studying the dinosaurs of today.
C (5) The dinosaurs were land reptiles.
C (6) There was great variation among the dinosaurs.

3. List four things that probably helped cause the dinosaurs to become extinct. (*P. 17, ¶ 4; p. 18, ¶¶ 1-3*)

4. What animals were the ancestors of the plesiosaurs, ichthyosaurs, and pterosaurs? (*P. 18, ¶ 5*)

5. Tell one important way in which *Pteranodon* was like *Stegosaurus*. (*P. 16, ¶ 3; p. 20, ¶ 6*)

6. Make a caption for the picture on page 18. (*A Pterosaur or Pterodactyl*)

7. Where did the reptile pictured on page 2 lay its eggs? (*P. 19, ¶ 2*)

8. Name five groups of reptiles that lived on after the dinosaurs, plesiosaurs, ichthyosaurs, and pterosaurs disappeared. (*Inside back cover*)

X. THE EARTH BEGINS TO BLOOM (pages 21-23)

Core Ideas

The first flowering plants appeared toward the end of the Age of Reptiles.

Flowers produce seeds.

Before seeds can be formed, the ovules that are to become seeds must be fertilized by means of pollen.

In the beginning most flowers were wind pollinated.

Later a partnership was formed between insects and flowering plants; the insects got food from the flowers, and at the same time carried pollen from flower to flower.

The partnership between insects and flowering plants had much to do with the success of both the flowering plants and the insects.

There are two great groups of flowering plants.

Success in neither the plant nor the animal world depends on size alone.

Possible Approach

Ask the class what would be wrong with a picture showing *Brontosaurus* eating grass. As a help, tell them that *Brontosaurus* lived in the Jurassic period, and let them consult the chart on the inside front cover. (*Grass is a flowering plant, and there were no flowering plants during the Jurassic.*) Show the class some grass flowers if possible. Then show some flower which, in contrast with grass flowers, is large and brightly colored. Take this flower apart and let the class find, by consulting the third paragraph on page 21, what the different parts are.

Activities

1. Follow suggestion No. 3 on page 36 of the unitext.

2. Look at the pictures in FLOWERS, FRUITS, SEEDS, another unitext in this series. In it you will find many pictures of different flowers and parts of flowers. You will find, too, a list of important flowering-plant families and an account of the purposes served by each part of a flower.

Study Problems and Exercises

1. Draw a diagram of some flower, labeling the parts.

2. The picture on page 20 is one of the illustrations for "The Earth Begins To Bloom." What connection is there between the picture and the text? *(P. 21, ¶ 5)*

3. Why should orchids have been chosen as one of the flowers to be pictured in this section? (*P. 22, ¶ 2*)
4. Underline the most advanced flowering plant in this list.

oak tree
water lily
cottonwood tree
daisy
willow tree

XI. Ancient Birds (pages 23-26)

Core Ideas

The birds descended from the reptiles.

Unlike their reptile ancestors, birds are warm-blooded.

Some ancient birds were much larger than any birds of today.

Some of the ancient birds were flightless, just as are some birds today.

Possible Approach

Call the attention of the class to the bird pictured at the top of page 23. Let them identify it by reading the first paragraph of the section. Then ask them to look for differences and similarities between *Archaeopteryx* and modern birds. Let them check their ideas by reading about *Archaeopteryx* in the text.

Activities

1. Get pictures of flightless birds of today.
2. Find pictures in reference books of *Aepyornis* and *Phororhacos*.
3. If possible, see for yourself that birds are warm-blooded by picking up a baby chicken, a canary, or some other kind of bird.

Study Problems and Exercises

1. Fill the blank in this sentence: The ancestors of *Archaeopteryx* were *(reptiles)*.
2. Tell three important ways in which *Archaeopteryx* differed from its ancestors. (*P. 24, ¶ 1*)
3. The bird pictured on page 24 looks somewhat like a duck. Tell three ways in which it was not like a duck. (*P. 25, ¶¶ 2-3*)
4. On page 26 you are told about three other birds that have become extinct. List them and tell some characteristic of each.

XII. THE MAMMALS COME INTO THEIR OWN; XIII. MAMMALS THAT WERE MISFITS (pages 27-34)

Core Ideas

The mammals descended from the reptiles.

The mammals are warm-blooded.

The possession of hair, the ability to move rapidly, and their care of their young were factors in the success of the mammals.

The large size of the brain in proportion to the size of the animal was another advantage.

The mammals soon became the dominant animals.

Through fossils, the history of some of the mammals of today has been traced clearly.

Not all mammals have been successful.

Many mammals flourished for a time and then became extinct.

It is hard to understand why some of the extinct mammals disappeared.

Possible Approach

Show pictures of the animals mentioned in the first paragraph of the section. Ask to what big group the animals in the pictures belong. When they have been identified as mammals, ask what shows at a glance that they belong to this group. (*Hair*) From the chart on the inside cover let the class find out whether the first mammals appeared before or after the first birds. Raise the question of what animals were the ancestors of the mammals, and have the class check their suggestions by reading the second paragraph of the section.

Activities

1. Ask someone not in your class to name ten animals. Make a list of the animals named and bring it to class. Let the class check the list with you to see how many of the animals named are mammals.

2. Collect for the bulletin board pictures of pouched mammals.

3. Notice the small horses on the outside cover of the unitext. Find in reference books other pictures of early horses. In ANIMALS OF YESTERDAY there is a series of silhouettes telling the story of the horse.

4. Read in a reference book an account of the Irish elk, another mammal that proved to be a "misfit."

5. Look in reference books for pictures of other mammals that have become extinct.

6. Find in reference books an account of the duck-billed platypus, a modern mammal so primitive that it lays eggs.

7. Make for the bulletin board a picture exhibit that will show the wide range in size and the variety in shape to be found among mammals.

8. Make another picture exhibit showing how mammals have been able to fit themselves into many different kinds of places. Your exhibit should show, for example, a bat, a mole, a whale, a monkey, and a polar bear.

9. For fun, read the poem, "Similar Cases," by Charlotte Perkins Gilman. It may be found in various collections of poetry.

Study Problems and Exercises

1. Tell five ways in which the little animal in the picture on page 27 was different from its reptile ancestors.

2. To what group of mammals do the opossum and kangaroo belong? (*P. 29, ¶ 1*)

3. What point do the stories of the horse and the elephant illustrate? (*Since they first appeared, some animals have changed greatly as the conditions under which they lived changed.*)

4. List the extinct mammals you are told about in "Mammals That Were Misfits." After each name tell some marked characteristic of that animal.

XIV. WILL THERE BE MORE CHANGE? (pages 35-36)

Core Ideas

Under natural conditions changes go on so slowly that it is difficult to see any changes in one person's lifetime.

Man is speeding up changes in his domesticated plants and animals.

There is nothing now to make us think that some other animals will in turn crowd out the mammals.

The greatest rivals of the mammals are the insects.

People have large brains which should help them plan ways of meeting any changes that occur.

Possible Approach

Raise this question: As you think of the long history of plants and animals on the earth, what might you reasonably expect for the future? (*That new plants and animals will appear that may crowd aside the kinds now on the earth.*) Then refer the class to the text to find out what evidence there is of change now and whether great changes are likely to occur.

Activities

1. Look through an illustrated seed catalogue. Notice the great numbers of varieties of some of the kinds of plants.

2. Make a collection of pictures of dogs to show that many breeds have been developed.

Study Problems and Exercises

1. What kinds of changes in plants and animals is man helping to bring about? (*P. 35, ¶ 3*)

2. Why is it difficult to tell whether some of the wild plants and animals of today are developing into new kinds of plants and animals? (*P. 35, ¶ 4*)

3. What group of animals now on the earth are the nearest rivals of the mammals? (*P. 36, ¶ 2*)

4. What great advantages does man have in the struggle with other animals for existence? (*P. 36, ¶ 3*)

Materials and Equipment

(See page 405)

Balance in Nature
Animals of Yesterday
Animals of the Seashore
Insects and Their Ways
Fishes
Toads and Frogs
Reptiles
Flowers, Fruits, Seeds
Science News Letter, July 4, 1942
Illustrated seed catalogue
"When Was Coal Formed?"—chart available through the Museum of Science and Industry, Chicago, Ill.
Pictures of some common mammals of today
Picture of a litter of puppies, kittens, or pigs
Fossils 4
6 flower pots
Microscope 4
Lump of coal
Modeling clay of different colors 5
Plaster of Paris 1
Soap to carve 2
6 beans
Algae, fungi, bacteria, liverwort, club mosses, and horsetails 4
Fern
Grass flowers
Large bright-colored flower

THE PLANT WORLD

(Note general information page 5)

I. INTRODUCTION (pages 3-4)

Core Ideas

Plants and animals are alike in so many ways that there is no sharp dividing line between the simplest plants and the simplest animals.

Most plants differ from most animals in these ways: they cannot move about by themselves, they make their own food, they have cellulose cell walls, they keep the power of growth all their lives, they respond to stimuli slowly, and they have a different body organization.

Scientists have worked out a plan for classifying the countless individual plants in the world.

Possible Approach

Have arranged on display a miscellaneous assortment of plants. Ask the class to tell to what big group of living things all the specimens displayed belong. Then raise the question of what characteristics enable the class to identify the specimens as plants rather than as animals. Discuss the characteristics named from the standpoint of whether they would serve to tell every plant from every animal. Check by reading the first eight paragraphs of the section. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activities

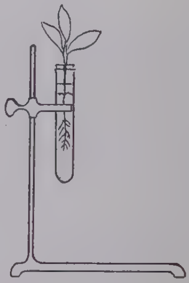
1. Place an *Elodea* leaf under the microscope. Look for the chloroplasts containing the green pigment chlorophyll. Also notice the cells of which the leaf is made.

2. Examine a drop of stagnant water under the microscope. You will see both tiny animals and tiny plants. Try to decide which are the animals and which the plants.

3. Ask at a conservatory or a florist's shop whether they have *Mimosa,* the sensitive plant. Seeds of this plant can also be bought from seed stores. The leaves will fold up and the stem will droop when touched.

4. Examine locust trees in the dark. Notice that their leaves are folded in "sleep." Try to find other plants that fold their leaves in the dark.

5. Carry out the following experiment to show plant movements, or response to stimuli: You will need a test tube with a cork to fit it, a corn, bean, or oat seedling, a clamp, and a ring stand. Fill the test tube almost full of water. Cut the cork in halves the long way. Make a groove in each half just large enough so that the stem of the seedling will fit in snugly when the two halves of the cork are put together. With the seedling in the groove of the cork, place the cork in the mouth of the test tube so that the roots are in the water. Be sure that the water will not leak out when the test tube is turned upside down. Place the test tube right side up in the clamp and fasten it to the ring stand. After the plant has been growing in this normal position for about twenty-four hours, turn the test tube upside down. Notice what happens.



Study Problems and Exercises

1. Most plants differ from most animals in what six ways? (*P. 3, ¶¶ 3, 4, and 5; p. 4, ¶¶ 1, 2, and 3*)

2. What do scientists consider in classifying plants? (*P. 4, ¶4*)

3. What is the point to the picture on page 4? (*P. 3, ¶ 1*)

II. CLASSIFYING PLANTS (pages 5-6)

Core Ideas

In the common plan of classification the plant kingdom is divided into four main divisions, or phyla.

Phyla are divided into classes, classes into orders, orders into families, families into genera, and genera into species.

Every plant has a scientific name made up of a genus name and a species name.

Possible Approach

Call attention to the chart on the inside back cover. Let the class try to interpret the chart. Then let them check their interpretation by reading the first seven paragraphs of the section.

Activities

1. Follow suggestion No. 1 on page 36 of the unitext.

2. Follow suggestion No 2 on page 36 of the unitext.

3. Identify as many as possible of the plants in the picture on page 5 and find out where they belong on the tree on page 2. (Those pictured are, from left to right: Irish moss, a brown alga; *Navicula,* a diatom; *Spirulina,* a blue-green alga; *Mnium,* a moss; boulder fern; mushroom; sunflower; Torrey pine; and wheat.)

4. Look up in Gray's Manual the scientific names of twenty plants you know well.

5. Collect leaves from as many different kinds of trees as you can. Press them between sheets of newspaper or pages of a magazine until the leaves are dry. Then, using Scotch tape, arrange them neatly in a scrapbook. Look up the scientific name of each tree and print it under the leaf.

6. Make a collection of herbaceous plants. Follow the directions given above for pressing, mounting, and labeling.

7. If you have a natural history museum in your community, visit their herbarium and find out what services they have to offer to students interested in collecting plants.

Study Problems and Exercises

1. Fill in the blank spaces with the word that is being defined.

A group of plants differing only slightly. (*Species*)
A group of species. (*Genus*)
A group of genera. (*Family*)
A group of families. (*Order*)
A group of orders. (*Class*)
A group of classes. (*Phylum*)
A group of phyla. (*Kingdom*)

2. Cross out each of the following statements that is not true.

There are more species than genera.
~~There are more phyla than families.~~
There are more genera than families.
There are more families than orders.
~~There are more orders than genera.~~
There are more orders than classes.
~~There are more classes than families.~~
There are more classes than phyla.

3. Complete the following classification of red clover.

Red clover belongs to the
- species (*pratense*) .
- genus (*Trifolium*) .
- family (*Leguminosae*) .
- order (*Rosales*) .
- class (*Dicots*) .
- subphylum (*Angiosperms*) .
- phylum (*Spermatophytes*) .
- kingdom (*plant*) .

4. To what phylum do each of the following belong?

Algae	(*Thallophytes*)
Mosses	(*Bryophytes*)
Ferns	(*Pteridophytes*)
Conifers	(*Spermatophytes*)

III. ALGAE (pages 7-10)

Core Ideas

Algae make up one of the groups of Thallophytes—the lowest of the four phyla of the plant kingdom.

All algae contain chlorophyll, the green coloring matter which enables green plants to make their own food, but in many cases the chlorophyll is hidden by other pigments.

Algae are divided into several groups partly on the basis of the pigments they contain.

Algae vary greatly in size.

Algae require a great deal of moisture; most of them are water plants.

Among the algae we find both sexual and asexual reproduction.

Although certain kinds may be a nuisance, algae are helpful in a number of ways.

(Note concerning pictures: The blue-greens on p. 6 are: *Oscillatoria, Gleocapsa,* and *Diplocolon.* Blue-greens on p. 7 are: *Nostoc, Anabaena,* and *Gleotrichia.* Green algae on p. 8 are: *Spirogyra, Protococcus,* and *Cladophora.* Red and brown algae on p. 9 are: *Polysiphonia,* a red, and *Nereocystis* and *Fucus,* browns.)

Possible Approach

Lead the class to read as much as they can about Thallophytes from the chart on the inside front cover and the "tree" on page 2. Then ask them to find by reading the first two paragraphs of the section how the three main groups of Thallophytes differ from one another.

Activities

1. Follow suggestion No. 3 on page 36 of the unitext.
2. Look for green algae in ponds, park lagoons, or pools of stagnant water.
3. If you have a natural history museum in your community, visit their exhibits of red and brown algae.
4. If you live near an ocean, look for red and brown algae on the beach and on the rocks when the tide is out.
5. Tie a piece of clean white muslin over the mouth of your faucet. Allow the water to run slowly for a few hours. Place a little of the material collected on the cloth on a microscope slide. You are likely to find many different kinds of diatoms if you examine the material under a microscope. Examine soil water or any sample of stagnant water for diatoms.

6. In the picture on page 8 the filaments at the left are *Spirogyra.* If you have not found any *Spirogyra* in ponds or pools, get some from a biological supply house. Examine it under the microscope. Notice the spiral chloroplasts. Try to find two filaments that are connected by tubes. Gametes pass through these tubes to unite with other gametes to form zygotes. Look for zygotes. They are egg-shaped. The picture on page 8 shows one.

7. Make a chart showing how the largest and the smallest algae compare in size.

Study Problems and Exercises

1. Do you think that "thallophytes" is a good name for the group to which it has been given? Why or why not? (*P. 7, ¶ 1*)

2. Into what three main groups are the Thallophytes divided? (*P. 7, ¶ 2*)

3. How do you account for the fact that the chief distinction between algae and fungi is not apparent from the tree on page 2? (*P. 7, ¶¶ 2 and 5*)

4. Would you be likely to find cacti and algae growing side by side? Why or why not? (*P. 7, ¶ 3*)

5. In front of each of the following sentences place:

Bg if it tells a characteristic of blue-greens.
G if it tells a characteristic of green algae.
D if it tells a characteristic of diatoms.
B if it tells a characteristic of brown algae.
R if it tells a characteristic of red algae.
N if it tells a characteristic of no algae.
A if it tells a characteristic of all algae.

(*D*) They have a glassy skeleton.
(*A*) They contain a green pigment called chlorophyll.
(*Bg*) They are the simplest of the algae.
(*B*) They are tough and leathery.
(*D*) They store oil in their bodies.
(*R*) They are delicate, feathery seaweeds.
(*Bg*) The pigments are scattered all through the protoplasm.
(*N*) They have true leaves, stems, and roots.

6. In what three ways can algae reproduce asexually? (*P. 8, ¶ 3; p. 10, ¶¶ 1 and 2*)

7. Complete each of the following sentences:

A male gamete is called a (*sperm*).
A female gamete is called an (*egg*).
A fertilized egg is called a (*zygote*).
In sexual reproduction in plants the new plant grows from the (*zygote*).

8. If you were setting up an exhibit to show the importance of algae, what would you try to get for your exhibit? Name at least three things. (*P. 10, ¶ 5*)

IV. BACTERIA (pages 11-12)

Core Ideas

Bacteria belong to the fungi, another group of Thallophytes.

Like all fungi, bacteria lack chlorophyll.

Bacteria are too small to be seen with the naked eye.

On the basis of shape bacteria are grouped into three groups: bacilli (rod-shaped), cocci (round), and spirilla (twisted).

Bacteria are very widespread.

Bacteria multiply only by asexual reproduction.

These tiny plants are so important that a whole science has been built up around them; they both help us and harm us in many ways.

Possible Approach

Call attention to the place of bacteria on the "tree" on page 2. Ask the class to tell what ideas they already have about this group of plants. Then let them find by scanning the section whether any of their ideas are mistaken.

Activities

1. Follow suggestion No. 4 on page 36 of the unitext.

2. Try to grow some bacteria on agar-agar. Look in a biology manual, which may be obtained in a library or in a biology laboratory, for instructions.

3. Examine the nodules on the roots of a clover plant, or on the roots of any member of the pea family.

4. Read *Microbe Hunters,* by Paul de Kruif.

Study Problems and Exercises

1. To what class do the bacteria belong? (*Fungi*)

2. Give another name for each of the following kinds of bacteria:

Rod-shaped bacteria	(*Bacilli*)
Ball-shaped bacteria	(*Cocci*)
Twisted bacteria	(*Spirilla*)

3. If a bacterium and all its offspring divided every twenty minutes and if none of the offspring died, how many bacteria would be produced from the original bacterium in eight hours? (*Over 16 million bacteria.*)

4. If you were setting up an exhibit to show the importance of bacteria, name at least five items you would try to get for the exhibit. (*P. 12, ¶¶ 2 and 3*)

5. "What a blessing if some scientist discovered a way of killing all the bacteria on the earth!" Comment on this remark.

V. OTHER FUNGI (pages 13-15)

Core Ideas

In addition to the bacteria, the fungi include the yeasts, molds, mushrooms, grain rusts, and slime molds.

These fungi lack chlorophyll just as do bacteria and cannot make their own food.

Yeasts, molds, and mushrooms both help us and harm us.

Grain rusts are all harmful and do a great deal of damage.

Spore formation is a common means of reproduction among the fungi.

Slime molds have some animal characteristics.

Possible Approach

Ask the class to find from the tree on page 2 the names of four groups of fungi besides the bacteria. Then let them find from the first paragraph of the section how these groups compare in numbers.

Activities

1. Follow suggestion No. 5 on page 36 of the unitext.
2. Follow suggestion No. 6 on page 36 of the unitext.
3. Follow suggestion No. 7 on page 36 of the unitext.

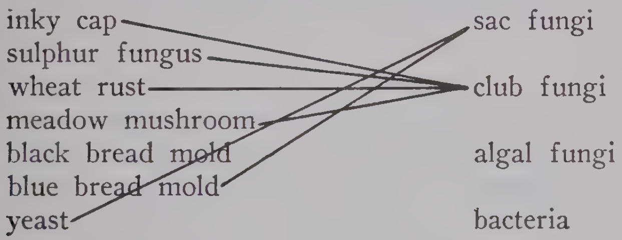
4. Find in DEPENDENT PLANTS, another unitext, pictures of many kinds of fungi.

5. Read in reference books the story of wheat rust. Examine specimens of wheat rust infection on wheat stems and on barberry leaves. Such specimens may be found in a biology laboratory or in a natural history museum.

6. Make a collection of pictures of fungi.

Study Problems and Exercises

1. Draw lines connecting each of the following fungi with the group to which it belongs:



2. Name each fungus described below:

(*Yeasts*)	Next to the bacteria they are the smallest of the fungi.
(*Black bread mold*)	They produce spore cases from which black spores are discharged.
(*Slime molds*)	They have an animal-like stage as well as a plant-like stage.
(*Wheat rust*)	They spend part of their lives on a wheat plant and part on a barberry plant.
(*Yeasts*)	They help us make bread.
(*Mushrooms*)	The largest of the fungi.

3. List at least three ways in which fungi are a nuisance or a danger. (*P. 12, ¶ 2; p. 13, ¶ 3; p. 14, ¶ 2; p. 15, ¶¶ 4 and 5*)

4. List at least three ways in which fungi help us. (*P. 12, ¶ 3; p. 13, ¶ 4; p. 14, ¶ 5; p. 15, ¶ 4*)

VI. LICHENS (page 16)

Core Ideas

Lichens are made of algae and fungi.
These plants are important chiefly as plant pioneers.

Possible Approach

Show the class a lichen of some kind. Remind them that they have already learned that lichens are made of algae and fungi. Show a picture of how the algae are surrounded by fungus threads. (There is such a picture in PLANT AND ANIMAL PARTNERSHIP, another unitext.) Raise the question of which plant, if either, is being benefited by the partnership. Check by reading the first paragraph of the section.

Activities

1. Tear a bit of lichen apart with dissecting needles and examine it under a microscope.
2. Examine specimens of lichen on display in a natural history museum.
3. Plant some lichens in a terrarium.
4. Read about lichens in PLANT AND ANIMAL PARTNERSHIP.
5. Find out how to use litmus paper in testing for acids.

Study Problems and Exercises

1. Mark these statements true or false:

X (1) All lichens are pale gray.
X (2) In the lichen partnership the algae get all the benefit.
X (3) Lichens always grow on rocks.
C (4) The algae in lichens are usually green algae.
C (5) In the lichen partnership the algae do the food-manufacturing.

2. In what two ways can lichens reproduce? (*P. 16, ¶ 3*)

3. Name three ways in which lichens are helpful. (*P. 16, ¶ 4*) Underline the way in which they help most.

VII. LIVERWORTS (pages 17-18)

Core Ideas

Liverworts make up one of the two groups of Bryophytes, the phylum which ranks just above the Thallophytes.

Liverworts are chiefly land plants.

All liverworts contain chlorophyll and can therefore make food for themselves.

In liverworts there is an alternation of generations; one generation produces spores while the succeeding generation produces sex cells, or gametes.

The gametophyte generation is the conspicuous one.

Liverworts are of interest to scientists partly because they are thought to have been the first land plants.

(Note concerning pictures: Liverwort pictured on p. 17 is *Marchantia;* liverwort on p. 18 is *Anthoceros.*)

Possible Approach

Show the class some liverworts. Find liverworts on the "tree" on page 2 and note that they belong to the Bryophytes. Then raise the question of why they are ranked higher than algae, fungi, and lichens. Let the class find any reasons they can, first by looking at the specimens, and then by glancing through the section in the unitext.

Activity

If you have a conservatory in your community, ask the gardener for a few liverwort plants. Try growing them in a moist terrarium at home or at school. Look for the different stages in their life cycle.

Study Problems and Exercises

1. For what reason are liverworts especially interesting to scientists? *(P. 17, ¶ 3)*

2. Why is it more likely that liverworts were the first land plants than that mushrooms were? *(P. 17, ¶ 3)*

3. List three ways in which liverworts differ from the green algae from which they are believed to have come. *(P. 17, ¶ 4)*

4. Find four errors in the following description of sexual

reproduction in liverworts. Tell what the errors are in the blanks which follow the description.

Liverworts produce two kinds of flowers. Some liverworts bear male sex organs. Some bear female sex organs. A sperm from a male sex organ is carried by the wind to an egg in a female sex organ. The sperm fertilizes the egg. The fertilized egg, or zygote, then begins to grow. It produces a gametophyte plant very different from the parent plants. The plant that grows from a zygote produces spore cases filled with spores. When the spores land on suitable moist earth, they grow into sporophytes. Because two distinct generations of plants follow each other, we say that there is an alternation of generations in liverworts.

1) (*Liverworts do not produce flowers.*)
2) (*Sperms are carried to the eggs by water, not by wind.*)
3) (*The zygote produces the sporophyte, not the gametophyte.*)
4) (*Spores do not produce sporophytes, but gametophytes.*)

5. Choose the correct ending for this sentence:
The picture at the bottom of page 18
(a) *shows both sporophytes and gametophytes.*
(b) shows only gametophytes.
(c) shows only sporophytes.

VIII. Mosses (pages 19-20)

Core Ideas

Mosses make up the second group of Bryophytes.

Like liverworts, mosses are mostly land plants.

There is an alternation of generations in mosses just as in liverworts, and the gametophyte generation is the conspicuous one.

Asexual reproduction is very common among mosses.

Mosses are widely scattered over the world.

(Note about pictures: Mosses on page 19 are sphagnum and *Polytrichum.*)

Possible Approach

Show specimens of mosses of different kinds. Let the group examine them with hand lenses. Ask whether the class sees any way or ways in which these mosses show advancement over the liverworts they saw. Let them check their ideas by reading the first two paragraphs of the section.

Activities

1. Plant some mosses in a terrarium. Look for sporophytes.
2. If prepared slides of the reproductive structures of the mosses are available, examine them.
3. Read "Mosses," an article in the June, 1948, *Natural History*.

Study Problems and Exercises

1. In what two ways have mosses improved on the liverwort plan? (*P. 19, ¶ 2*)

2. Underline each moss in the following list:

Irish moss
reindeer moss
peat moss
long moss

3. In the blank spaces below place:

L if the statement is true of liverworts.
M if the statement is true of mosses.
N if the statement is true of neither.
B if the statement is true of both.

(*B*) They show an alternation of generations.
(*M*) The gametophytes have erect branches.
(*M*) The gametophytes of some species produce male and female sex organs on the same branch.
(*B*) The zygote is the beginning cell of the sporophyte generation.
(*B*) Sperm cells swim to the eggs.
(*N*) The sporophyte is more conspicuous than the gametophyte.
(*N*) They cannot make their own food at any stage in their life-history.
(*L*) The gametophytes are characteristically flat and leaflike.

4. Choose the correct ending for this sentence:

The picture at the top of page 19
(a) *shows both sporophytes and gametophytes.*
(b) shows only gametophytes.
(c) shows only sporophytes.

5. Choose the correct ending for this sentence: The picture at the bottom of page 20

(a) *shows a young gametophyte.*
(b) shows a young sporophyte.
(c) shows both sporophytes and gametophytes.

IX. HORSETAILS (page 21)

Core Ideas

Horsetails belong to the phylum of Pteridophytes.

Pteridophytes differ from the phyla below them in having roots and woody stems.

Although they are now small and inconspicuous, horsetails formed an important part of the ancient forests from which our coal was made.

There is an alternation of generations among the horsetails, but the sporophyte generation is the conspicuous one.

Possible Approach

Show specimens of horsetails. Ask the class to find out what they can about this group of plants from the chart on the inside cover and the "tree" on page 2.

Activities

1. Look for horsetails growing along railroad tracks.
2. Visit the exhibits of horsetails at your natural history museum.
3. Dig up a horsetail plant. Examine the underground stem and roots. Pull apart the sections of the aerial branches. Notice the manner in which the branches grow longer.

Study Problems and Exercises

1. In what way are the Pteridophytes that lived millions of years ago important to us? (*P. 21, ¶ 1*)

2. Give two reasons why the Pteridophytes were able to grow larger than the Bryophytes. (*P. 21, ¶ 2*)

3. Mark these statements true or false:

C (1) Horsetails have gritty branches.
X (2) The horsetails of today have broad, thick leaves.

C (3) The sporophyte generation is more conspicuous than the gametophyte generation.
C (4) The main stem of a horsetail is underground.
X (5) The gametophytes of horsetails grow from fertilized eggs.
C (6) The gametophytes are tiny, flat green plants.
X (7) Many of the horsetails in our tropical forests get to be a hundred feet high.
X (8) Horsetails have gradually increased in size throughout the centuries since they first appeared.
X (9) Horsetails are so successful that they are crowding out many other plants in regions of fertile soil.
C (10) Horsetails are more closely related to ferns than to liverworts.

4. Choose the correct ending for this sentence: The picture at the top of page 21
   (a) *shows sporophytes.*
   (b) shows gametophytes.
   (c) shows both sporophytes and gametophytes.

X. CLUB MOSSES (page 22)

Core Ideas

Club mosses form a second group of Pteridophytes.

Although now small and inconspicuous, club mosses made up an important part of the coal forests.

As with the horsetails, there is an alternation of generations, and the sporophyte generation is the conspicuous one.

Possible Approach

Show specimens of club mosses. Ask the class to find out what they can about this group of plants from the chart on the inside front cover and the tree on page 2.

Activities

1. Visit a conservatory and ask to see any club mosses they may have.
2. Find out whether the florists's shop in your neighborhood has ground pine for sale.
3. Find pictures of coal forests.

4. In LIFE THROUGH THE AGES, another unitext, find out something about the animals that flourished when the club mosses were at their height.

Study Problems and Exercises

1. In what way is the geologic history of the club mosses like that of the horsetails? *(P. 22, ¶ 1)*

2. Name two genera of club mosses. *(Lycopodium and Selaginella)*

3. What important advance does *Selaginella* show over *Lycopodium? (P. 22, ¶ 5)*

4. Why could you watch *Selaginella* for years without noticing an alternation of generations?

5. Choose the correct ending for this sentence:
The picture at the top of page 22
(a) *shows the sporophyte generation.*
(b) shows the gametophyte generation.
(c) shows both sporophytes and gametophytes.

XI. FERNS (pages 23-24)

Core Ideas

Ferns are the most common and best-known Pteridophytes.

The sporophyte generation, as in the case of the horsetails and club mosses, is the conspicuous one.

Ferns (that is, fern sporophytes) have well-developed roots, stems, and leaves.

Fern leaves can be told from all other leaves by their veining and by the way in which they are rolled up when young. (Note about picture: The ferns on page 23 are: maidenhair fern, toothed wood fern, and Boston fern.)

Possible Approach

Show one or more fern specimens. Ask the class to find out all that they can about ferns from the chart on the inside front cover and from the "tree" on page 2. Raise the question of whether the geologic history of ferns is similar to that of horsetails and club mosses. Check by reading the first two paragraphs of the section.

Activities

1. Follow suggestion No. 9 on page 36 of the unitext.

2. Examine spore cases of ferns under a hand lens.

3. Examine spores of ferns under a microscope.

4. Visit a conservatory and look at any ferns on display there.

5. Try to grow some fern gametophytes by sprinkling fern spores on sterile agar in a petri dish. Keep the dish covered.

6. Examine prepared microscope slides of fern gametophytes. Look for the male organs and female organs. The sex organs are made of only a few cells. Sometimes you can see a large egg in the female organ.

Study Problems and Exercises

1. Into what three classes are the Pteridophytes divided? (*P. 23, ¶ 1*)

2. Are the ferns sold by florists sporophytes or gametophytes? (*Sporophytes*)

3. In what two ways can fern leaves be told from other leaves? (*P. 23, ¶ 5*)

4. What are the little brown spots found on the under side of the leaves of many ferns? (*P. 23, ¶ 6*)

5. Fill in the blank spaces:

When a fern spore reaches *(suitable)* soil, which has plenty of *(moisture)*, it may grow into a tiny, heart-shaped *(gametophyte)*. The sex organs are located on the under side of the *(gametophyte)*. Sperms reach the eggs by *(swimming)*. The fertilized egg grows into a *(sporophyte)*, which while very young gets its food from the parent *(gametophyte)*. As soon as the sporophyte sends up a *(green)* leaf it can make food for itself. The leaves of the *(sporophyte)* will produce more spores and the cycle will start over again.

6. Make titles for the left half and the right half of the picture on page 24. (*Fern Gametophyte; Fern Leaf with Spore Cases*)

XII. Gymnosperms (pages 25-28)

Core Ideas

Gymnosperms make up one of the two groups of Spermatophytes, or seed plants.

Seeds enable plants to live through periods not favorable for growth.

Gymnosperms form a less conspicuous part of the plant kingdom now than in ancient times, but the group still is a very important one, for it contains many of our timber trees.

The seeds of gymnosperms are formed in cones and are naked.

In the gymnosperms the gametophyte generation has almost been lost to view.

Seeds are formed by sexual reproduction—they result from a union of sperm and egg.

Among the groups of present-day gymnosperms are the ginkgoes, cycads, and conifers.

Possible Approach

Call attention to the fact, as shown on the chart on the inside front cover and on the tree on page 2, that all the plants ranking above the ferns are seed plants. Show a variety of seeds and lead the class to identify them as seeds. Discuss the role which seeds play in the life of a seed plant. Check by reading the first paragraph of the section.

Activities

1. Visit a conservatory and ask to see any cycads on display.
2. Follow suggestion No. 11 on page 36 of the unitext.
3. Obtain some seeds of the cycad *Zamia* from a biological supply house. Cut one open and look for the embryo, food, and seed coat.
4. Look for the ginkgo, or maidenhair tree, in parks or along city streets.
5. Visit the conifer exhibits in your natural history museum.
6. Identify as many conifers growing in your parks or city lawns as you can. Use the chart on page 28 to help.
7. Make blueprints of conifer sprays.

Study Problems and Exercises

1. Name three present-day orders of gymnosperms and give one characteristic of each. (*P. 26, ¶¶ 1, 2 and 3*)

2. Mark these statements true or false:

X (1) Spermatophytes are distributed chiefly by means of their spores.
X (2) Ferns are scattered chiefly by means of their seeds.
C (3) Gymnosperms are scattered chiefly by means of their seeds.
C (4) Spores are much simpler structures than seeds.
C (5) The seeds of gymnosperms are naked.
C (6) Seeds can survive periods not suitable for growing.
C (7) Gymnosperms appeared on the earth before the flowering plants.
X (8) The cycads are of great economic importance.
X (9) The ginkgoes are of great economic importance.
C (10) The conifers are of great economic importance.

3. Fill in the blank spaces in the following account of how white pine seeds are formed:

The white pine produces two kinds of *(cones)*, one larger than the other. The smaller ones have spore leaves called *(stamens)*, which produce *(pollen)*. The spore leaves of the larger *(cones)* produce spore cases called *(ovules)*, each of which produces a single large spore. The *(ovules)* later become the seeds. A tiny male gametophyte develops inside each *(pollen)* grain. The male gametophyte produces *(sperms)*. A female gametophyte develops inside the *(spore)* of each ovule. The female gametophyte produces *(eggs)*. Pollen grains are carried by the *(wind)* to the *(female)* cones. *(Pollen)* tubes grow from the pollen grains into the ovules to allow the *(sperms)* to reach the *(eggs)*. After *(fertilization)* the ovules develop into winged seeds.

XIII. Angiosperms (pages 29-35)

Core Ideas

Angiosperms, the "flowering plants," form the second of the two great groups of seed plants.

The flowering plants are by far the largest and most conspicuous group of land plants.

The flowering plants rank at the top of the plant kingdom.

The seeds of flowering plants are produced by the flowers.

A complete flower is made up of sepals, petals, stamens, and pistils.

Stamens and pistils are the parts necessary for seed production.

Pollen from a stamen must reach a pistil as a first step in seed formation; as a second step a sperm from a pollen grain must unite with the egg in an ovule in the base of the pistil.

The seeds of flowering plants are always inclosed in a case.

On the basis of their seed structure the flowering plants are divided into the monocots and the dicots.

Flowering plants have many ways of scattering their seeds.

Possible Approach

Call attention to the picture at the top of page 29. Ask whether and why that picture is suitable as a heading for the section. Check by reading the first three paragraphs of the section.

Activities

1. Follow suggestion No. 12 on page 36 of the unitext.
2. Follow suggestion No. 13 on page 36 of the unitext.
3. Follow suggestion No. 14 on page 36 of the unitext.
4. Follow suggestion No. 15 on page 36 of the unitext.
5. Follow suggestion No. 16 on page 36 of the unitext.
6. Put some pollen in a drop of water on a microscope slide and examine it under both low and high power. Examine the pollen of as many plants as you can.
7. Make a seed collection. Find out how each of the seeds in your collection is scattered.

Study Problems and Exercises

1. Why are the flowering plants called angiosperms? (*P. 29, ¶ 1*)

2. Fill in the following table:

Part of Flower	Location	Function
Calyx . . .	(*Outside the petals*)	(*Protects the bud.*)
Corolla . . .	(*Surrounding the stamens*)	(*Attracts insects.*)
Stamens . .	(*Surrounding the pistil*)	(*Produce pollen.*)
Pistil	(*Center of flower*)	(*Contains the ovules.*)

3. Copy the picture of the pistil from the illustration at the bottom of page 30. Label the stigma, style, and ovary.

4. Copy the picture of the stamen from the illustration on page 30. Label the anther.

5. Identify each of the following:

(*Male gametophyte*)	The structure which develops inside a pollen grain.
(*Female gametophyte*)	The structure which develops inside an ovule.
(*Male gametophyte*)	The structure which produces sperms.
(*Female gametophyte*)	The structure which produces eggs.
(*The style*)	The structure through which the pollen grain sends its tube.
(*A zygote*)	The structure which results from the union of egg and sperm.
(*Ovary*)	The structure which becomes the fruit.

6. List four differences between dicots and monocots. (*P. 32, ¶¶ 3-4*)

7. Classify these plants as dicots or monocots: morning glory (*D*), pumpkin (*D*), hyacinth (*M*), pansy (*D*),cotton (*D*), plum (*D*), wheat (*M*), orchid (*M*), peanut (*D*), date palm (*M*).

8. What is one of the chief differences between the composite family and other plant families? (*P. 33, ¶ 2*)

9. Show by drawings at least three means of vegetative reproduction among flowering plants. (*P. 33, ¶ 3*)

10. Give one reason why flowering plants are so successful in crowding their rivals off the earth. (*P. 33, ¶ 4*)

11. Ten plants are listed below. After each tell to what family it belongs and name two other plants in the same family:

1) beet (*Goosefoot, p. 34*)
2) dandelion (*Composite, p. 35*)
3) catnip (*Mint, p. 35*)
4) oak (*Beech, p. 34*)
5) cherry (*Rose, p. 34*)
6) radish (*Mustard, p. 34*)
7) tomato (*Nightshade, p. 35*)
8) onion (*Lily, p. 31*)
9) sugar cane (*Grass, p. 31*)
10) Jack-in-the-pulpit (*Arum, p. 31*)

Summary Exercises

1. In each of the following groups of words and phrases draw a line through the one which does not belong with the others. In the blank space provided tell why it does not belong.

a) bacteria
mushrooms
~~orchids~~
yeasts
bread mold
(*It does not belong to the fungi.*)

b) lily
iris
grass
~~willow~~
daffodil
(*It is not a monocot.*)

c) bean
~~hawthorn~~
peanut
redbud
alfalfa
(*It is not in the pea family.*)

d) hemlock
~~ginkgo~~
cedar
juniper
spruce
(*It is not a conifer.*)

e) Thallophytes
Spermatophytes
Pteridophytes
~~Gametophytes~~
Bryophytes
(*It is not a phylum.*)

f) Are leathery
Have holdfasts
Grow very large
~~Have glassy skeletons~~
May have air bladders
(*It is not a characteristic of brown algae.*)

g) ~~Produce pollen~~
Have a mycelium
Must have ready-made food
Reproduce by spores
Give flavor to cheese

(*Molds do not produce pollen.*)

h) Alternation of generations
Conspicuous gametophyte
Inconspicuous sporophyte
Sperms reach eggs through water
~~Two cotyledons~~

(*Bryophytes have no cotyledons.*)

i) Usually evergreen
Softwoods
Cones
Water-carrying tubes
~~Fruits~~

(*Fruits are not characteristic of conifers.*)

j) Petals
Stamens
~~Cotyledon~~
Pistil
Sepals

(*A cotyledon is not a flower part.*)

2. Below is a list of plant characteristics. In the spaces provided write the name of at least one plant group having the characteristic.

Have no true roots, stems, or leaves	(*Thallophytes, Bryophytes, algae, fungi, lichens, liverworts, or mosses*)
Have a blue pigment in addition to chlorophyll	(*Blue-green algae*)
Have a glassy skeleton	(*Diatoms*)
Have no chlorophyll	(*Fungi*)
Have a gametophyte that is more conspicuous than the sporophyte	(*Bryophytes, liverworts, or mosses*)
Produce their seeds in cones	(*Conifers*)
Reproduce by means of seeds	(*Spermatophytes, Gymnosperms, or Angiosperms*)
Bear seeds within fruits	(*Angiosperms*)
Resemble algae but lack chlorophyll	(*Algal fungi*)
Have gritty stems	(*Horsetails*)
Usually have flower parts in fours or fives	(*Dicots*)

Bear naked seeds	(*Gymnosperms, conifers, cycads, or ginkgoes*)
Are made up of algae and fungi living together	(*Lichens*)
Have leaves with parallel veins	(*Monocots*)
Have veins which always fork into two equal branches	(*Ferns*)

3. In each blank space write the word which is being defined:

(*Fiddleheads*)	The young, rolled-up leaves of ferns.
(*Zygote*)	The structure formed by the union of an egg and sperm.
(*Ovary*)	The part of the pistil which contains the ovules.
(*Cotyledons*)	The part of a bean seed which contains stored food.
(*Chlorophyll*)	The green pigment which enables plants to make their own food.
(*Protoplasm*)	The living material of plants and animals.
(*Chloroplasts*)	Little bodies containing chlorophyll found in the cells of most of the higher plants.
(*Stamens*)	The part of a flower which produces pollen.
(*Embryo*)	The part of a seed which develops into a new plant.
(*Holdfasts*)	The structures by means of which brown algae become anchored to rocks.
(*Sporophyte*)	The plant generation which produces spores.
(*Gametophyte*)	The plant generation which produces eggs and sperms.
(*Diatomaceous earth*)	Earth made up of skeletons of diatoms.
(*Cocci*)	Bacteria which are ball-shaped.

(*Myscelium*)	The network of colorless threads which form a part of every mold plant.
(*Spores*)	The structures by means of which most of the lower plants are scattered.
(*Style*)	The neck of a pistil.

Materials and Equipment

(See page 405)

- Microscope, slides, and cover glasses 4
- Test tube, with cork to fit 4
- Ring stand 4
- Clamp 4
- Prepared slides of bacteria, reproductive structures of mosses, and fern gametophytes 4
- Terrariums for mushrooms, lichens, liverworts, mosses 4
- Dissecting needles 4
- Hand lenses 4
- Petri dishes, covered 4
- Scotch tape 1, 3, 5, 8
- White muslin
- Agar-agar 3, 4
- Covered bowl
- Blueprint paper
- Litmus paper 4
- Acids to test
- Cake of yeast 2
- Piece of white bread 2
- *Elodea* 4
- *Spirogyra* 4
- A leguminous plant
- Specimens, preferably living, of lichens, liverworts, mosses, horsetails, club-mosses, ferns 4
- A variety of seeds, including corn, bean, several other dicots, several other monocots, several conifers, and the cycad *Zamia*
- A variety of flowers to dissect
- Seed catalogues
- Gray's Manual
- Microbe Hunters, by Paul de Kruif
- Natural History for June, 1948
- Dependent Plants
- Life Through the Ages
- Plant and Animal Partnership

SOIL

(Note general information page 5)

I. INTRODUCTION (page 3)

Core Ideas

Soil is one of our country's most valuable resources.
We have let millions of acres of good farmland be ruined.
How to save our soil is a problem important to all of us.

Possible Approach

Give the class copies of SOIL. Ask why anyone except farmers should study about soil. After a brief discussion, let the class find in the introductory section any statements they can that back up their arguments. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activities

1. Make a poster telling how important it is for us to save our soil.

2. Choose some one of the important crops raised in our country. From reference books find out how much of that crop the soil of our country produces every year. Report to the class what you find out.

3. Look through the book for pictures that show farmland that has been or is being ruined. (*Pp. 26, 27, 31*)

Study Problems and Exercises

1. Why are the people of our country more concerned about saving the soil than they were a hundred years ago? (*P. 3, ¶ 4*)

2. Soil has been called "the backbone of our nation." Why is the phrase appropriate? (*P. 3, ¶ 5*)

II. Soil in the Making (pages 4-11)

Core Ideas

Most soil is made up chiefly of small rock particles.

Masses of solid rock may be broken up into small particles in many ways.

Running water, wind, waves, and glaciers may carry broken-up rock from one place to another.

The breaking up of rock into small particles is only the beginning of the making of good soil.

In almost all tillable soil, there are at least two layers of soil above the bedrock.

Topsoil contains humus, material that comes from plants and animals.

In the soil there are enormous numbers of small plants and animals that play an important part in soil-making.

The earthworm is one of the animals that help build good soil.

Nature needs very long periods of time for building good topsoil.

Possible Approach

Show the class a sample of dry, sandy soil. Explain that all soil has been made—that there was none on the earth in the beginning. Ask what there was on the earth from which soil could be made. Let the class check their suggestions by reading the first paragraph of the section. Then give each member of the group a magnifying glass and a small amount of the sample of sandy soil. Ask each pupil to crumble the soil given him, spread it out on a sheet of white paper, and examine it with the magnifying glass to see whether any of the rock particles in it are large enough to be identifiable as rock particles.

Activities

1. Follow Activities 1, 2, and 3 on page 84 of this manual.

2. Examine a weathered stone that has been cracked open. Notice how different the fresh surfaces look from those that have been exposed to the weather.

3. On pages 33, 34, and 35 of Stories Read from the Rocks, another unitext in the series, you will find a map showing how much of North America was covered by ice during the Great Ice Age, a picture of a glacial boulder, and a picture of a rock scratched by a glacier. Look at these illustrations, and read the accompanying

text (*pages 28-34*). Was the part of the country where you live covered with ice during the Ice Age?

4. If you have any waterworn pebbles, bring a few specimens to show to the class.

5. Bring for a bulletin board exhibit any pictures you can find that illustrate "Soil in the Making."

6. If any excavating is being done near where you live, try to see in the sides of the excavation the difference between the topsoil and the subsoil.

7. Look in a garden or a patch of bare soil for earthworm castings. Dig up a few earthworms, and put them in a large terrarium. Find out by observation as much as you can about these soil-makers.

Study Problems and Exercises

1. Name five ways in which solid rock may be broken up. (*Pp. 4-8*)

2. Name four ways in which broken-up rock may be moved from one place to another. (*Pp. 8-9*)

3. Tell one important difference between the top layer of soil shown in the picture on page 10 and the layer beneath it. (*P. 10, ¶ 2*)

4. Give in one sentence the main idea of the fourth paragraph on page 10.

5. Tell four ways in which earthworms help build good soil. (*P. 10, ¶ 5; p. 11, ¶¶ 1-2*) Does the help of earthworms in soil-making end when the earthworms die? Explain your answer. (*P. 10, ¶ 3*)

6. Show that you understand what these words mean: topsoil, subsoil, bedrock, weathering, humus.

7. Give in your own words the most important idea of the third paragraph on page 11.

III. Why Plants Need Soil (pages 12-14)

Core Ideas

Soil holds plants in place.

Soil furnishes plants with water.

Soil furnishes plants with certain minerals they must have.

Our field and garden plants need fourteen chemical elements, most of which they must get from the minerals in the soil.

Possible Approach

Show the class some common potted plant such as a geranium. Call attention to the fact that the pot is filled with soil. Ask why the plant needs soil. Let the class check their suggestions by reading the first three paragraphs of the section.

Activities

1. Fill a terrarium half-full of garden soil. Plant a few white beans two inches deep along one wall of the terrarium. They should be against the glass so that they can be watched as they grow. Look at the beans each day. Notice how the roots spread out in the soil.

2. Get a small potted geranium plant. Take it out of the pot and wash the soil from its roots as gently as possible. Find out how well it will grow in a jar of water.

3. Plan other experiments that will show that plants need soil.

4. Collect samples of as many as you can of the elements plants need. Set up an exhibit for other classes to see.

5. There are many recent books and magazine articles about plant chemiculture, or soilless gardening. Using some of these books or articles as references, make a report about this way of raising plants.

Study Problems and Exercises

1. Copy from page 13 the list of elements plants need. Put an *S* after those that plants get from minerals in the soil. (*P. 13, ¶ 3*)

2. Mark each of the following sentences "True" or "False."

X (1) Our common crop plants get most of the water they need through their leaves.

C (2) Our common crop plants get from the air the oxygen they need.

C (3) There is an enormous amount of nitrogen in the earth's ocean of air.

X (4) Our crop plants take in nitrogen from the air and use it in making food for themselves.

C (5) Our crop plants get the carbon they need from the carbon dioxide in the air.

IV. How Soils Differ (pages 14-16)

Core Ideas

There are many different kinds of soil.

Soils differ in color, size of soil particles, amount of humus present, size and shape of the clumps in which the soil particles are arranged, amount of acid or alkali present, and amount of needed minerals present.

Soil particles are classified according to their size into sand, silt, and clay.

Much of our good soil is loam, a mixture of sand, silt, clay, and humus.

Possible Approach

Show samples of as many kinds of soil as possible. Let the class examine the different soils and look for differences between them. Explain that there are differences between the soils in addition to those that can be seen. Let the class find from the text what some of those differences are.

Activities

1. Follow suggestion No. 1 on page 36 of the unitext.

2. You can easily test soil to find whether it is acid or alkaline. For the testing you will need a strip of blue litmus paper and one of pink litmus paper.

Put a layer of the soil you wish to test in a saucer or some other shallow dish. Add water to the soil until it is very moist. Lay the two strips of litmus paper on the soil. Press them down against the surface. Look at them in ten minutes.

Acids make blue litmus paper turn pink. Alkalies make pink litmus paper turn blue. If the blue litmus paper turns pink and the pink litmus paper stays pink, the soil is acid. If the pink litmus paper turns blue and the blue litmus paper stays blue, the soil is alkaline. If neither strip of paper changes color, the soil is neutral.

3. Find in the book a picture which shows that the addition of humus to soil changes its color. (*P. 10*)

4. Put a little dry loam in a small iron pan. (The lid of a tin can will do.) Heat the pan over a Bunsen burner. Smoke will soon begin to rise from the soil. The humus is being burned out of the soil, and the smoke is coming from the burning humus. Forest fires not only do great damage to forests, but they sometimes ruin the soil in which the forests are growing by burning out the humus.

Study Problems and Exercises

1. List six ways in which soils may differ from one another.

(*See the second of the core ideas listed for this section.*)

2. The black soil in the picture on page 13 is loam. What, then, do you know about it? (*P. 15, ¶ 2*)

V. SOIL AND WATER (pages 17-23)

Core Ideas

The plants we raise in our soil need water for many purposes.

Plants may die from lack of water or from an over-supply of water.

Plants vary in the amount of water they need.

Our crop plants take in water through their roots.

Some of the water that falls as rain or snow evaporates as it falls or soon afterward, some runs off, and some sinks into the ground.

Some of the water that sinks into the ground may reach the water table, the level at which water stands in the ground.

The size of the soil particles has a great deal to do with how much water a soil can hold.

The soil that can hold the most water is not always the most productive.

Water that reaches the water table is not necessarily lost to plants.

In many cases arid land can be made productive by irrigation, and wet land by drainage.

Possible Approach

Raise the question of why plants need water. Let the class check their suggestions by reading the first paragraph of the section.

Activities

1. Follow suggestion No. 2 on page 36 of the unitext.
2. Follow suggestion No. 3 on page 36 of the unitext.
3. Follow suggestion No. 4 on page 36 of the unitext.
4. Stand a lump of sugar on end in a saucer containing a little water colored with red ink. Cover the upper end of the loaf of sugar with a layer of powdered sugar. Watch the colored water rise to the powdered sugar and then stop. This experiment will help you understand how a layer of very fine soil keeps the soil below it from losing moisture as rapidly as it otherwise would.
5. Follow suggestion No. 5 on page 36 of the unitext.

Study Problems and Exercises

1. Look at the inside cover. Tell four reasons why plants of the kind shown here must have water. (*P. 17, ¶1*)

2. Many farmers in the rich farmland region of Illinois tile their fields so that after heavy rains excess water will be carried away. These same farmers sometimes have their crop yields reduced greatly by drought. Would it be better if they did not tile their land? Why or why not? (*P. 17, ¶ 4*)

3. What is the difference between run-off and fly-off? (*P. 19, ¶¶ 2-3*)

4. Make captions for the pictures and diagrams on pages 16, 17, 18, 19, and 20. (P. 16—*Desert Land;* p. 17—*A Very Wet Meadow;* p. 18—*A Great Dam;* p. 19—*Melons Raised on Irrigated Land;* p. 20—*What Happens to the Rain That Falls*)

5. What change would you probably have to make in the diagram on page 21 if you wished to show the region after a week of heavy rain? What change would you have to make if you wished to show the region after a long period of drought? (*P. 21, ¶ 1*)

5. Mark each of the following sentences "True" or "False."

C (1) Crop plants can be drowned.

X (2) The only way in which root hairs help plants is to anchor the plants firmly in the ground.

X (3) All the rain that falls sooner or later sinks into the ground.

X (4) Desert regions never have heavy rains.

X (5) The more water a soil will hold, the better the soil is for crops.

X (6) Adding humus to soil always helps it hold more water.

X (7) Water that reaches the water table of a region is lost so far as the plants growing above it are concerned.

C (8) We may do more harm than good by draining swampland.

VI. KEEPING SOIL FROM WEARING OUT (pages 23-27)

Core Ideas

Soil is likely to become worn out if no attempt is made to put back into the soil the minerals taken from it by our crop plants.

The elements most likely to be lacking in soil are nitrogen, phosphorus, and potassium.

A carefully planned crop rotation helps keep soil from wearing out.

Plowing under a crop, spreading manure, and adding certain prepared fertilizers help replace the minerals taken from the soil.

Soil should be tested before fertilizers are added to it.

Earthworms are important in keeping soil from wearing out.

Humus makes soil more tillable and improves the air and moisture conditions in the soil.

Soil toxins may make soil unproductive.

Too much acid or alkali may make soil unproductive.

The same steps that keep soil from wearing out can also build up poor soil.

Possible Approach

Copy on the board this table:

IMPORTANT MINERALS TAKEN FROM AN ACRE OF SOIL IN A YEAR BY CERTAIN CROPS

Crop	Nitrogen	Phosphorus	Potassium
Wheat................	58 lbs.	10 lbs.	35 lbs.
Corn	74 lbs.	12 lbs.	56 lbs.
Cotton	102 lbs.	18 lbs.	59 lbs.

Ask what is likely to happen to soil in which crops such as these are raised year after year. Let the class check their suggestions by reading the first three paragraphs of the section.

Activities

1. Pull up a clover plant or a bean plant and look for nodules on its roots. If you do not understand what these nodules are, read again page 25.

2. If you have a powerful microscope, try to see a few of the bacteria from one of the nodules.

3. If possible, get a small soil-testing kit and test some soil according to the directions in the kit.

4. Get two pots of the same size and fill them with garden soil. Plant grass seed in both pots. Stand the pots side by side. Give them equal amounts of water, but to the water given to one pot add some fertilizer recommended for grass. Watch to see whether the fertilizer makes the grass grow better.

5. If you live in a farming community, find out about some crop rotation being used by a farmer in your community. Make a report to the class about this rotation. Does it include a legume? Does it include any crop to be plowed under?

6. Examine in some garden catalogue the list of fertilizers for

sale. What elements are mentioned most often in the descriptions of these fertilizers? Would you expect these to be mentioned most often, in view of the first paragraph on page 24?

7. Fill a test tube half-full of water. Add about a teaspoonful of vinegar. Test the mixture of water and vinegar with litmus paper. You will find that it turns blue litmus paper pink. Now add a pinch of baking soda to the weak vinegar in the test tube. Test again with blue litmus paper. Keep adding baking soda, a very little at a time, until blue litmus paper is no longer turned pink when you test the liquid in the test tube. The baking soda neutralizes the acid in the vinegar. Crushed limestone added to acid soil works in the same way.

8. Plan a one-minute talk you might give to try to convince a cotton grower that he should give up the plan he had always followed of raising cotton in the same fields year after year.

Study Problems and Exercises

1. Make captions for the pictures on pages 22 and 23. (P. 22—*Good Farmland;* p. 23—*An Abandoned Farm*)

2. Show that you understand what these terms mean: legume, crop rotation, nitrogen, soil toxins, alkali soils.

3. What do you think of this crop rotation? Cotton, oats, corn. (*P. 24, ¶¶ 1-2*)

4. List five ways of replacing in soil the minerals taken from it by crops. (*Raising legumes; plowing under a cover crop such as grass; adding manure; adding crushed minerals; adding wastes from packing plants.*)

VII. HOW OUR SOIL IS BEING STOLEN (pages 28-31)

Core Ideas

Wind and running water are our chief soil thieves.

The wearing away of soil by wind and running water is called soil "erosion."

There are different types of erosion by running water.

Water erosion goes on fastest where rains are heavy, the soil is bare, and slopes are steep.

Wind erosion goes on fastest where the wind is strong and the soil is bare and dry.

Millions of acres of our farmland have been ruined by erosion

Men have speeded up erosion by tearing off the natural plant covering and plowing the land.

Sooner or later wind and water drop their loads.

Possible Approach

Reread with the class the second paragraph on page 3. Ask them to suggest ways in which our soil is being "stolen." Let them check their suggestions by reading the first paragraph of the section.

Activities

1. After a heavy rain, look for signs of soil erosion. You will be most likely to find them on bare slopes.
2. In *Soil, Water, and Man,* by Murl Deusing, read more about how our soil is being "stolen" from us.
3. Try to work out a demonstration that will show that a plant covering helps protect soil from erosion. A layer of moss makes a very good plant covering for use in a demonstration of this kind.
4. If you have seen any farmland that has been badly damaged by wind or water, make a report about it to the class.
5. Make a poster asking farmers to guard their soil against erosion.

Study Problems and Exercises

1. What does the picture on page 28 have to do with a discussion of the "stealing" of our soil? (*P. 29, ¶ 1*)
2. Pick out and give in your own words the main ideas of the paragraphs listed below. Give the main idea or ideas of each paragraph in one sentence if possible. Do not have more than two for any of the paragraphs.

P. 28, ¶ 1
P. 30, ¶ 6
P. 31, ¶ 1
P. 31, ¶ 2
P. 31, ¶ 3
P. 31, ¶ 4

If you picked out the main ideas correctly, your sentences make a good summary of this section. (*See Core Ideas.*)

VIII. Stopping Our Soil Thieves (pages 32-36)

Core Ideas

There are three general plans for lessening erosion by wind: breaking the force of the wind, making the soil particles form clumps which cannot easily be carried away, and covering the soil so that the wind cannot get at it.

There are four general plans for protecting soil from water erosion: making water sink into the soil rather than run off, checking the flow of the water that does run off, making this water flow through protected channels, and covering and binding together the soil so that it cannot easily be washed away.

There are many ways of putting these general plans into practice.

It is much easier to stop erosion in its early stages than in its later ones.

In a region which is badly eroded, no one farmer can do much to stop erosion.

The government is now helping farmers to save their soil.

Possible Approach

Ask the class to suggest ways in which wind and running water can be kept from "stealing" our soil. Keep the list of suggestions made, and let the class revise it after they have read the text and have carried on the activities and discussions suggested.

Activity

If you live in a community in which soil is being damaged by erosion, look for signs that the farmers are trying to stop the erosion.

Study Problems and Exercises

1. Make captions for the pictures on pages 30, 31, 32, 33, 34, and 35. (P. 30—*Grass Roots;* p. 31—*Pines Planted in Gully;* p. 32—*Contour Tilling;* p. 33—*Contour Tilling* (close-up view); p. 34—*Strip Planting;* p. 35—*Grassed Waterway*)

2. Tell how each of the four ways of fighting soil erosion shown in the pictures helps. (*P. 33, ¶ 3; p. 34, ¶¶ 2-3; p. 35, ¶ 1; p. 35, ¶ 3*)

3. Name two ways not shown in the pictures of preventing water erosion. (*P. 35, ¶¶ 2 and 4*)

4. Give in your own words the main ideas of the last two paragraphs of the section.

Materials and Equipment

(See page 405)

Magnifying glasses for class 4
Samples of various kinds of soil
Bunsen burner 4
Deep pan 1
Terrarium 4
Tall, wide-mouthed bottle
Small iron pan 4
7 flowerpots 1
Plate of glass 1
Compound microscope 4
Soil-testing kit 4
Test tube 4
Garden catalogue

Soil, Water, and Man, by Murl Deusing
STORIES READ FROM THE ROCKS
Glass tubing 4
Lichen growing on a rock
Weathered stone cracked open
Potted geranium plant
Litmus paper 3, 4
White beans, grass seed, radish seed
Fertilizer for grass
Loaf sugar
Powdered sugar
Vinegar
Baking soda

ASK THE WEATHERMAN

(Note general information page 5)

I. INTRODUCTION (pages 3-4)

Core Ideas

The Weather Bureau furnishes many different kinds of services.

The services of the Weather Bureau are very important.

Possible Approach

Ask the class how many of them hear or see weather forecasts every day. Discuss these questions: Where do the forecasts come from? Who pays for them? Of what value are they? What other work besides making forecasts does the weatherman do? Give the class copies of ASK THE WEATHERMAN and have them check their ideas by reading the first four paragraphs of the section. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activity

(Note: Many teachers will doubtless wish to use THE WAYS OF THE WEATHER in connection with ASK THE WEATHERMAN. Duplication of activities in the teaching outlines for these two unitexts has been avoided. Most of the activities suggested for the two would be appropriate for either.)

Follow suggestion No. 5 on page 36 of the unitext.

Study Problems and Exercises

1. List the different workers mentioned in paragraph 3 on page 3. Tell why each one is concerned with the weather.

2. The cities in which there are first-order Weather Bureau stations are named on the weather maps on pages 15 and 20. If your home is not in one of these cities, what is your nearest main-

II. A WEATHERMAN'S INSTRUMENTS (pages 5-14)

Core Ideas

The elements of weather are: (1) air pressure, (2) wind direction, (3) wind velocity, (4) temperature, (5) humidity, (6) amount of cloudiness, and (7) amount of rain and snow.

At Weather Bureau stations there are instruments for measuring the various elements that go to make up the weather.

The instruments used by the weatherman not only tell what weather conditions are but help the weatherman predict what they will be.

Possible Approach

Show the class all the weather instruments available. Let the class try to tell what each measures. Have them find, by referring to page 5, what elements in the weather the instruments available do not measure.

Activities

1. Keep a record of the weather conditions for a week on the chart provided for the purpose. (This chart may be obtained without charge from the publisher.)

2. Follow suggestion No. 4 on page 36 of the unitext.

3. If there is a Weather Bureau station near you, visit it and examine the instruments there.

4. In OUR OCEAN OF AIR, another unitext in this series, there is a story of Otto von Guericke's water barometer. You may be interested in reading it.

5. In an encyclopedia or some other reference book read the story of Torricelli, the inventor of the mercury barometer.

6. In an encyclopedia or some other reference book, read the story of Galileo, the inventor of the thermometer.

7. On the first rainy day put a large tin can out in the open to serve as a rain gage. Measure the depth of the water in the can after the rain is over.

8. Make an air thermometer in this way: Get a flask and a one-holed rubber stopper to fit it. Insert a glass tube about a foot long in the stopper. Turn the flask upside down, and fasten it by means of a clamp to a ring stand so that the end of the tube is in a beaker full of water colored with red ink. Drive a few bubbles of air out of the flask by heating it. As the air in the

flask cools, colored water will rise in the tube. Mark the height of the water in the tube when it stops rising. The thermometer is now complete. If the temperature rises, the air in the bulb will expand and the water will go down. If the temperature falls, the air in the bulb will contract and the water will rise higher in the tube.

9. There are several different kinds of toys that measure humidity roughly, e.g., a little house with figures that come out and go in as the weather changes, and an umbrella that changes color as the weather changes. If you have any such toys, bring them to class and try to find out and explain to the class how they work.

Study Problems and Exercises

1. List all the weather instruments described on pages 6 to 14, and tell the purpose of each.

2. If it takes 10 inches of snow to make one inch of water, how would you record on a weather chart the amount of precipitation if there was a foot and a half of snow? (*1.8 inches*)

3. Suppose the temperature on two summer days is the same. On one day the difference between the readings of the wet-bulb thermometer and the dry-bulb thermometer is 12 degrees; on the second day it is 2 degrees. On which day is there most likely to be a shower? Why? (*On the second day, because the humidity is higher*)

III. WEATHER MAPS (pages 15-16)

Core Ideas

Weather maps give a picture of weather conditions in all parts of the country and help in the making of weather forecasts.

On weather maps isobars connect places of the same air pressure and show where the highs and lows are.

Isotherms connect places of the same temperature.

Possible Approach

Give each member of the class a weather map (or call their attention to the one on page 15). Have them find out from either the map or the unitext what the symbols used on weather maps mean. Show on the board how isobars and isotherms are drawn. Ask how, if highs and lows were not marked with words, one could tell a high from a low. Let them check by reading the second paragraph on page 16.

Activities

1. Examine the weather map on the chart designed to accompany this unitext. (This chart may be obtained without charge from the publisher.) Read what the chart tells about the map. Compare the map with the maps on page 20 of Ask the Weatherman. Is there any place on these two maps where the isobars are as close together as they are around the big low in the map on the chart?

2. If possible, look at the weather map for yesterday. What was the barometer reading at the Weather Bureau station nearest your home? What was the lowest reading reported for the country? The highest reading? From what direction was the wind blowing at the station nearest you? What was the temperature there? How many highs are shown on the map? How many lows?

Study Problems and Exercises

1. What is the lowest pressure shown on the map on page 15? (*29.25*) What is the highest pressure shown on the map? (*30.5*)

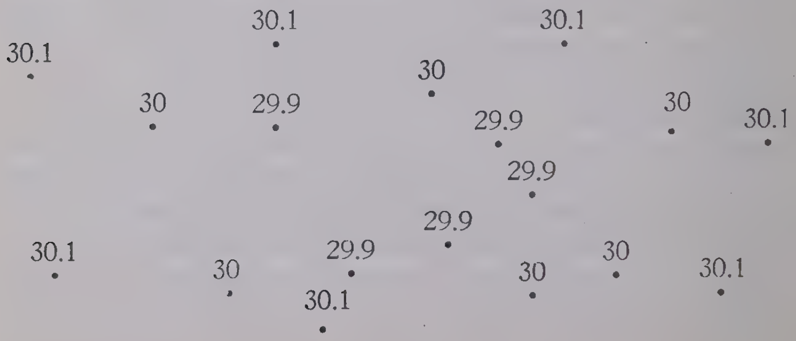
2. What is the highest temperature shown on the map on page 15? (*70° F.*) What is the lowest temperature? (*—40° F.*)

3. Was it raining or snowing in your locality when the map on page 15 was made?

4. What was the condition of the sky in your locality when the map on page 15 was made?

5. What was the general direction of the wind in your locality when the map on page 15 was made?

6. The air pressure for various cities is given below. Draw the isobars.



7. Show by using them in sentences that you know what these words mean: isobar (*P. 15, ¶ 3*), isotherm (*P. 16, ¶ 3*), cyclone (*P. 16, ¶ 2*), anticyclone (*P. 16, ¶ 2*).

IV. THE WEATHERMAN IS LOOKING UP (pages 16-18)

Core Ideas

In order to make accurate forecasts, weather forecasters need to know conditions high above the ground as well as conditions on the ground.

Weathermen have various instruments for finding out about conditions high above the ground.

Possible Approach

Call the attention of the class to the heading of this section. Ask what they think it means. Have them check their ideas by reading the first paragraph of the section.

Study Problems and Exercises

1. The observer in the picture on page 17 is watching a pilot balloon. What is he trying to find out by doing so? (*P. 17, ¶ 2*)
2. What is a radiosonde? (*P. 18, ¶ 2*)

V. FORECASTING THE WEATHER (pages 19-22)

Core Ideas

Weather moves.

In general, weather moves from west to east.

Forecasting weather accurately is not easy.

Studying the movements of highs and lows helps in weather predicting.

At present long-range weather forecasts are not possible, but it may in time be possible to predict the weather for a year or more in advance.

Possible Approach

Show the class a series of weather maps on which there are well-defined highs and lows (or call their attention to the maps on page 20). Lead them to conclude that weather moves eastward in our part of the world. Let them check their conclusions by reading the first paragraph of the section.

Activities

1. Follow suggestion No. 1 on page 36 of the unitext.
2. Follow suggestion No. 2 on page 36 of the unitext.
3. Follow suggestion No. 3 on page 36 of the unitext.

4. Pretend that you are a Weather Bureau worker and that it is 7:30 A.M.—the time to send a report of conditions at your station to other stations. With the instruments you have at hand make out as nearly complete a report as you can.

5. Read in the *Saturday Evening Post* for June 8, 1935, "Old Almanacs and Prognostications" by Dr. A. S. W. Rosenbach. This article describes many old attempts to forecast the weather.

6. In THE SUN AND ITS FAMILY, another unitext in this series, there are a picture and a description of sunspots. They will help you understand the third paragraph on page 22.

7. Read in the *Saturday Evening Post* for February 10, 1940, "Weather for Sale" by H. N. Salterlee.

Study Problems and Exercises

1. "There is a very hard snowstorm in Cleveland today. Probably Des Moines will get it tomorrow." Criticize the second statement. (*Weather moves from west to east.*)

2. Tell two reasons why weather forecasting is not easy. (*P. 19, ¶ 7*)

3. Mark each of the following sentences "True" or "False."

X (1) Forecasters can predict weather accurately six months ahead.
C (2) The newest kind of weather forecasting is called "air-mass analysis."
C (3) Lows are often accompanied by rain or snow.
X (4) Lows are always accompanied by rain or snow.
C (5) The forecasts made by the Weather Bureau are right a very large part of the time.

VI. WEATHER AND FLYING (pages 22-25)

Core Ideas

The science of the weather helped greatly in the development of the science of aviation.

The development of aviation has brought about more intensive study of the weather.

Possible Approach

Tell the class that men in training for the aviation service have to take courses in meteorology, the science of the weather. Ask them to suggest reasons. What would aviators need to know especially about the weather? Let them check by reading the first five paragraphs of the section.

Activity

If possible, visit an airport. Look for signs there that weather is very important to aviators.

Study Problems and Exercises

1. How have the science of the weather and the science of aviation helped each other? (*P. 22, ¶ 5*)

2. Make a weather forecast for aviators. Of course, you will have to imagine the conditions you report, but you can show that you understand what an aviator needs to know about weather conditions. (*P. 24, ¶ 1*)

VII. STORM WARNINGS (pages 25-27)

Core Idea

Sending out storm warnings is one of the most important services of the Weather Bureau.

Possible Approach

Read to the class an account of a hurricane. (There is a good reference given under Activities, suggestion No. 2, on page 242 of this manual.) Raise the question of what good it does for the government to send out warnings of such a storm. Let the class check by reading the first sentence of the second paragraph of the section.

Activity

Look up storm signals in an almanac or encyclopedia. What is the warning on the inside of the front cover? Plan other warnings. (*Northwest storm*)

Study Problems and Exercises

1. Is Detroit likely to be badly damaged by a hurricane? Why or why not? (*P. 26, ¶ 1*)

2. Hurricanes, you notice, do not follow the paths that ordinary highs and lows follow. How can the forecasters of Florida tell when a hurricane is on its way? (*P. 25, ¶ 3*)

VIII. HERALDS OF FROST AND FLOOD (pages 27-30)

Core Idea

Warnings of frost and flood sent out by the Weather Bureau save an enormous amount of property each year.

Possible Approach

Read to the class the second sentence of this section. Let them try to explain it. Then let them check their ideas by reading paragraphs 2, 3, and 4 of the section.

Study Problems and Exercises

1. Explain how frost warnings help cranberry growers save their crops. (*P. 28, ¶ 2*)

2. Why are floods never a surprise to the weatherman? (*P. 28, ¶ 4*)

IX. FOREST FIRES AND THE WEATHER (pages 30-31)

Core Ideas

Weather conditions have a great deal to do with the number and severity of forest fires.

Weather forecasters sometimes play an important part in the fighting of forest fires.

Possible Approach

Ask the class to think of all the relationships they can between forest fires and the weather. Then let them check these relationships and find further ones by reading the section.

Study Problems and Exercises

1. Suppose the report of an observer in one of our western forests is, "Humidity 25%; percentage of water in duff 7%." What would be done? (*P. 30, ¶¶ 4 and 5*)

2. How can a forecaster help if a fire has already started? (*P. 31, ¶ 3*)

X. OTHER SPECIAL FORECASTS (pages 31-32)

Core Idea

The Weather Bureau makes many special forecasts for shippers and fruit-growers.

Possible Approach

Call attention to the forecasts for shippers on the daily weather maps. Let the class try to picture a situation in which such a forecast would be helpful.

Study Problems and Exercises

1. How do weather forecasts help orchardists? (*P. 31, ¶ 5*)

2. How do the forecasts of our government compare with those issued by other governments? (*P. 32, ¶ 3*)

XI. WEATHER RECORDS (pages 32-34)

Core Ideas

Weather records serve to build up our knowledge of the climates of the different parts of the world.

Weather records play an important part in many lawsuits.

The Weather Bureau keeps very accurate weather records.

Possible Approach

Reread with the class the third paragraph on page 3. Call attention to "testifying in lawsuits." Ask the class to imagine a lawsuit in which a weatherman would be asked to testify. Then read with the class the first four paragraphs of the section.

Study Problems and Exercises

1. Tell what the last sentence of the section means. (*The Weather Bureau services help practically everyone.*)
2. What is climate? (*P.33, ¶2*)

XII. KEEPING TRACK OF THE CROPS (page 34)

Core Ideas

The weather and the condition of crops are very closely tied together.

The Weather Bureau keeps accurate records of crop conditions in the whole country.

The Weather Bureau records of crop conditions influence prices in many parts of the world.

Possible Approach

Let the class suggest reasons for the fact that it is the Weather Bureau that keeps track of the crops of the country. Then have them check their suggestions by reading the section.

Study Problems and Exercises

1. Explain the first sentence of the section in your own words. (*P.34, ¶2*)
2. Are our Weather Bureau's crop bulletins of any interest in other countries? Why or why not? (*P.34, ¶3*)

XIII. ATTEMPTS TO CONTROL THE WEATHER (pages 34-36)

Core Idea

Many attempts have been made to control the weather, but none of them have been very successful.

Possible Approach

Let the class tell of any attempts they know about to control the weather. Then let them find other ways by reading.

Activity

Occasionally there are reports in newspapers of rain dances or some other such effort to control the weather. Bring to class any such reports you find.

Study Problems and Exercises

1. What, at present, are our most successful efforts to control the weather? (*P. 35, ¶ 4*)
2. Explain the last sentence of the section in your own words.

Materials and Equipment

(See page 405)

Weather instruments:
  Aneroid barometer 4
  Mercury barometer 4
  Mercury thermometer 4
  Recording thermometer 4
  Recording barometer 4
  Psychrometer 4
  Hygrometer 4
Chart to accompany unitext
Weather maps for one week
Calendar showing weather forecasts 3
Tin can
Flask 4
1-holed rubber stopper to fit flask 4
Glass tube 1 ft. long 4
Clamp 4
Ring stand 4
Beaker 4
Red ink

BEYOND THE SOLAR SYSTEM

(Note general information page 5)

I. INTRODUCTION; II. SEEING STARS (pages 3-6)

Core Ideas

Stars are suns, but they are not all single suns.

There are stars in all directions from the earth.

Some heavenly bodies are called "stars" which are not true stars.

Stars give off their own light.

All the stars except the sun are far, far beyond the solar system.

The sun and all the heavenly bodies that travel around it make up the solar system.

What stars are visible on a clear night depends on (1) the time of day, (2) the time of year, and (3) the position of the observer on the earth.

Possible Approach

Give the class copies of BEYOND THE SOLAR SYSTEM. Ask them to glance through the book at the pictures and find out what the book appears to be chiefly about. Let the class try to explain why a book about the stars should be called "Beyond the Solar System." Have them check their ideas by reading the first five paragraphs of "Seeing Stars." (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activity

Follow suggestion No. 5 on page 36 of the unitext.

Study Problems and Exercises

1. Stars are suns. If you counted the number of stars shown in the chart on page 8, would you be sure that you knew how many suns were represented on the chart? Why or why not? (*No—see p. 3, ¶ 1*)

2. Make a title for the diagram on page 4.

3. What is wrong with this diagram so far as positions are concerned? • Sun • Pluto • Nearest star (*Pluto should be much nearer sun.*)

4. What does the diagram on page 5 show? (*P.5, ¶4*)

5. What does the diagram on page 6 show? (*P.6, ¶2*)

6. Look at the star charts on pages 8 and 9. These are accurate charts of a part of the southern sky as seen from the same place on the earth at the same hour in the evening. Why are they not alike? (*Different time of year*)

7. Tell an important difference between a falling star and a real star. (*P.4, ¶3*)

III. Sky Distances (pages 7-8)

Core Ideas

Astronomers often measure distances to the stars in light-years.

The nearest star is so far away that it takes light more than four years to reach us from it.

Possible Approach

Tell the class that if Sirius, the brightest star in the sky, should explode tonight, it would be nearly nine years before anyone would see it explode. Let them try to explain why. (*It is so far away that the light it gave off as it exploded would not reach us for nearly nine years.*) Let the class check by reading the section.

Activity

Draw a cartoon to illustrate the sentences at the top of page 8.

Study Problems and Exercises

1. What does the next-to-last sentence on page 7 mean? (*That it takes light 400 years to reach us from Antares.*)

2. Suppose the great group of stars pictured on page 2 was destroyed half a million years ago. About how long would it be before the people of the earth would see it disappear? (*About half a million years—See p.8, ¶1.*)

IV. How Many Stars Are There? (pages 8-10)

Core Ideas

Only a few thousand stars can be seen with the naked eye.

There are countless millions of stars too far away to be seen without a telescope.

Possible Approach

Ask the class to tell how many stars they think they can see when they look up into the sky on a clear night. Let them check their estimates by reading the first paragraph of "How Many Stars Are There?"

Study Problems and Exercises

1. The heading of this section is a question. Write a short paragraph to answer it.

2. Explain why the two pictures on page 10 are not alike. (*P. 9, ¶ 1*)

V. GROUPS OF STARS (pages 10-16)

Core Ideas

The stars which are bright enough to be seen without a telescope are arranged in groups called "constellations."

The path along which the sun seems to move among the stars is called the "zodiac."

Possible Approach

Mount on the bulletin board the chart provided to accompany this unitext. (This chart may be obtained without charge from the publisher.) Raise the questions: What are such groups of stars called? Why should not all the symbols for stars on the chart be the same? Let the class check their answers by reading the first three paragraphs of "Groups of Stars" and by looking at the chart on the inside front cover.

Activities

1. Follow suggestion No. 2 on page 36 of the unitext.
2. Follow suggestion No. 3 on page 36 of the unitext.
3. Take turns drawing constellations on the board for the other members of the class to identify.
4. On star maps locate all the constellations shown in the little star maps in the unitext.

Study Problems and Exercises

1. On the inside covers of the unitext each of four constellations is shown in three ways. The first map shows the constellation as it appears in the sky. The second shows the constellation as it is usually drawn on star maps. The third shows the constellation as some of the people of early times pictured it. Draw some other constellation in these same three ways.

2. List all the constellations shown and labeled in the book. Put a *Z* after the constellations which are in the great belt of constellations called the "zodiac." (*Check by the marginal pictures on pages 18 and 19.*)

VI. NAMING THE STARS (pages 16-17)

Core Idea

Different stars have been named in different ways.

Possible Approach

Write these four names of stars on the board: Sirius, Beta Lyrae, 27 Canis Major, Wolf 457. Let the class make any suggestions they can about how stars come to have such names as these. Let them check their suggestions by reading the section.

Study Problems and Exercises

1. One name of the very bright star near the upper left-hand corner of the chart on page 8 is Capella. Another name for it is Alpha Aurigae. What does this second name suggest about Capella? (*Brightest start in Auriga*)

2. If you read about a star called 61 Cygni (Cygni comes from Cygnus), what would the name tell you about the star? (*Very faint star*)

VII. THE TWENTY BRIGHTEST STARS (pages 18-19)

Core Ideas

Stars are classified into magnitudes according to their brightness as we see them from the earth.

The brightness of a star depends on how much light it is giving off and how far away it is.

There are twenty first-magnitude stars.

Possible Approach

Ask the class to examine the list on page 18 of the 20 brightest stars. Call attention to the great differences in the distances of these stars from us. Discuss these questions: What must be true of Rigel, Antares, and Deneb? Why, if all the stars were equally close to us, would Sirius not be the brightest star in the sky? Let them check any ideas they express by reading the first paragraph of "The Twenty Brightest Stars."

Activity

Follow suggestion No. 1 on page 36 of the unitext.

Study Problems and Exercises

1. Exactly what does it mean to say that a star is a first-magnitude star? (*P. 18, ¶ 2*)

2. Copy the map of Orion on page 12. Tell the magnitude of each star on the map. The magnitude key is given on the inside front cover.

VIII. THE POLESTAR (pages 19-20)

Core Ideas

The axis of the earth is pointed almost exactly toward the North Star.

The North Star is important as a guide to travelers in the Northern Hemisphere.

The rising and setting of the stars is caused by the turning of the earth on its axis.

Because the earth's axis is pointed toward it, the North Star does not rise or set.

In our country there are some stars near the North Star that never rise or set.

The farther north you are in our country, the more stars there are that do not rise or set.

Possible Approach

Let the class try to explain the picture on page 28. Have them check by reading "The Polestar."

Activity

Follow suggestion No. 4 on page 36 of the unitext.

Study Problems and Exercises

1. Suppose you live in a part of the country in which the end star of the handle of the Big Dipper is sometimes below the horizon. In what direction would you have to travel to reach a place where none of the stars of the Big Dipper ever disappear below the horizon? (*North*)

2. Look at the map of Draco on page 15. Notice that the only star in that constellation which is named is a faint star. Why is this star important enough to be given a name on the map? (*P. 20, ¶ 2*)

3. Look at the map of Lyra on page 15. Only one star of this constellation is named. Tell two reasons why this star is important enough to be given a name on the map. (*P. 20, ¶ 2*)

IX. STAR DWARFS AND STAR GIANTS (pages 20-23)

Core Ideas

Stars vary greatly in size.

Stars vary greatly in density.

Stars vary greatly in temperature.

The color of a star depends on its temperature.

Our sun is a medium-sized star.

Possible Approach

Ask the class what the title of the section suggests. (*That some stars are very much larger than others.*) Have them find out, by reading the section, whether their ideas are right.

Study Problems and Exercises

1. How does our sun compare in size with other stars? (*P.23, ¶2*)
2. What are white dwarfs? (*P.21, ¶1*)
3. Compare Betelgeuse in size with our sun. (*P.22, ¶4*)
4. Are double stars always made up of "twin" stars? Explain your answer. (*P.21, ¶¶2 and 3*)

X. NOVAE (pages 23-24)

Core Ideas

Stars may suddenly change in brightness.

Novae, or "new stars," are simply stars that have suddenly increased in brightness.

Possible Approach

Read with the class the story of Tycho Brahe in the first four paragraphs of "Novae." Then let them find out for themselves what novae are.

Study Problems and Exercises

1. Explain what novae are. (*P.24, ¶4*)
2. In what way is "novae" not an entirely satisfactory name for the stars discussed in this section? (*Not really new stars.*)

XI. OUR STAR CITY (pages 25-26)

Core Ideas

Our sun is one of the millions of stars which make up the Milky Way Galaxy.

The Milky Way itself is made of light from stars too far away to be seen separately.

Possible Approach

Ask the class how many of them have seen the Milky Way. Let one or more of those who have describe it. Raise the question of what it is and let the class check their suggestions by reading the third, fourth, and fifth paragraphs of "Our Star City."

Activity

Make a model of our Galaxy out of modeling clay. Cut it in two horizontally. Place two tiny balls in the proper places to stand for the sun and the earth. The third paragraph on page 26 shows where they should go.

Study Problems and Exercises

1. What is the Galaxy? (*Our star city*)
2. Explain the band of light we call the Milky Way. (*P. 26, ¶ 4*)

XII. NEBULAE (page 27)

Core Ideas

Nebulae are clouds of star dust or gas.

Some nebulae are bright while others are dark.

Nebulae vary in shape.

Possible Approach

Call the attention of the class to the pictures on pages 23, 26, and 29. What do the pictures show? Ask the class to find out, by reading the section, what nebulae are and why the picture on page 23 is so different from the other two.

Study Problems and Exercises

1. In the book two nebulae in Orion are pictured. What is the chief difference between these two nebulae? (*P. 27, ¶¶ 3 and 4*)

2. Are nebulae always the same shape? Back up your answer by referring to illustrations in the book.

XIII. FAR OUT IN SPACE (pages 27-29)

Core Ideas

Star clusters are great balls of stars.

All the star clusters that have been found are in our own Galaxy.

There are several millions of galaxies much like our own Milky Way Galaxy.

Galaxies are sometimes called "star cities," "spirals," or "spiral nebulae."

New telescopes will probably show still more star cities far out in space.

Possible Approach

Ask the class to look again at the picture on page 2 and to find two other pictures of spiral nebulae in the book. Raise the question of why these were not discussed under "Nebulae." Have the class find the answer by reading the fourth and fifth paragraphs on page 28 and the first on page 29.

Study Problems and Exercises

1. Two different kinds of star groups are described in this section. What are they? (*Clusters and spirals*)
2. Notice the title of the picture on page 22. Give three other terms, any one of which might have been substituted for "spiral nebula" in the title. (*Star city, galaxy, spiral*)
3. List all the pictures of entire galaxies in the book. (*Pp. 2, 22, 31*)
4. Express as briefly as you can the relationships of
   a) The earth to the solar system (*Earth a part of solar system.*)
   b) The solar system to our Galaxy (*Solar system a part of our Galaxy.*)
   c) Our Galaxy to the whole universe (*Our Galaxy a part of the whole universe.*)

XIV. ARE THERE OTHER SOLAR SYSTEMS? (page 29)

Core Idea

No other solar systems besides our own are known, but distant stars may have solar systems.

Possible Approach

Call attention to the title of this section. Let the class attempt to answer the question before reading the section.

Study Problems and Exercises

1. Answer the question asked in the title of this section.
2. Why can't the question be answered more definitely?

XV. STAR MYTHS; XVI. THE ROYAL FAMILY (pages 30-35)

Core Ideas

The people of long ago made up stories to explain the questions about the stars which puzzled them.

Myths were the beginning of science because they were attempts to explain what people saw about them.

Possible Approach

Read with the class "Star Myths," and explain that myths are included in a science book only because they were forerunners of science.

Study Problems and Exercises

1. Why should any space in a science book be given to star myths? (*P. 30, ¶ 2*)

2. Name the constellations in the Royal Family. Where in the sky would you look for these constellations? (*Perseus, Andromeda, Cepheus, Cassiopeia—North*)

XVII. STAR SUPERSTITIONS (pages 35-36)

Core Idea

There are many unfounded beliefs about the effect of the stars on people's lives.

Possible Approach

Ask whether the class has ever heard the word "astrology." If any have, ask where they have heard it, what it means, and whether it is based on what scientists have found out by studying the stars. Let them check their ideas by reading the section.

Study Problems and Exercises

1. Many of the early astronomers had to earn their livings by astrology. Why were people interested in astrology? (*P. 35, ¶ 2*)

2. Name two ways in which stars help us. (*P. 36, ¶ 1*)

Summary Exercises

1. Classify the following into three groups. Put an appropriate heading above each list. (*Planets, Stars, Constellation*)

Saturn (P)
Polaris (S)
Ursa Major (C)
Arcturus (S)
Neptune (P)
Draco (C)
Aldebaran (S)
Sirius (S)
Orion (C)
Mercury (P)
Rigel (S)
Betelgeuse (S)
Pluto (P)
Lyra (C)
Canopus (S)
Cassiopeia (C)
Earth (P)
Sun (S)
Jupiter (P)
Auriga (C)

2. Mark each of the following sentences "True" or "False."

C (1) Stars are suns.
X (2) All stars are single suns.
C (3) There are stars in all directions from the earth.
C (4) Stars give off their own light.
X (5) There are many stars within our solar system.

X (6) In December exactly the same stars are visible in Canada that are visible in South Africa.

X (7) Proxima Centauri, the nearest star, is about twice as far away from us as the sun.

X (8) Millions of stars can be seen with the naked eye.

X (9) "Constellation" and "solar system" mean the same thing.

X (10) "Constellation" and "galaxy" mean the same thing.

X (11) "Constellation" and "star cluster" mean the same thing.

C (12) Different stars have been named in different ways.

X (13) Fourth-magnitude stars are much brighter than first-magnitude stars.

C (14) The farther north you are in our country the more stars there are that do not rise or set.

X (15) Stars are all the same size.

X (16) Stars are all the same color.

C (17) The temperature of a star can be told roughly by its color.

X (18) Our sun is the largest of all known stars.

C (19) Our sun is a member of the Milky Way Galaxy.

C (20) Distant stars may have solar systems like ours.

C (21) Our solar system is only a small part of the whole universe.

X (22) The stars influence our fortunes greatly.

C (23) Stars may suddenly change in brightness.

X (24) Nebulae are all bright clouds of star dust or gas.

C (25) The turning of the earth on its axis makes stars appear to move across the sky or in a circle around some point in the sky.

Materials and Equipment

(See page 405)

Chart which accompanies unitext
Star maps 4, 8
Flashlight 1
Modeling clay 5
Black paper 5

THE EARTH'S CHANGING SURFACE

(Note general information page 5)

I. AN ISLAND THAT BLEW ITSELF UP; II. AN EARTHQUAKE AND A NEW SHORE LINE; III. A RIVER THAT CHANGED ITS COURSE; IV. CUTTING APART TWO CONTINENTS; V. CHANGE AND MORE CHANGE; VI. AN EVERLASTING WAR (pages 3-9)

Core Ideas

The earth's surface is constantly changing.

Many of the changes in the earth's surface are brought about by man.

Many of the changes are natural changes.

There is an everlasting war between the land and the sea.

The natural changes in the earth's surface may be thought of as parts of this war.

Air, water, and ice both build up land and destroy it.

The wearing away of land by air, water, and ice is called "erosion."

The building up of land by air, water, and ice is called "deposition."

Volcanism and diastrophism both build up land and tear it down.

Possible Approach

Read to the class the most recent newspaper or magazine article you can get that describes a volcanic eruption, an earthquake, the building of a large artificial lake, or some other spectacular change in the earth's surface. Ask the members of the group to tell of other such changes that they have seen or read of. Give the class copies of THE EARTH'S CHANGING SURFACE and ask them to read "An Island That Blew Itself Up," "An Earthquake and a New Shore Line," "A River That Changed Its Course," and "Cutting Apart Two Continents."

List on the board in two columns the changes described in these four sections of the unitext and the changes discussed orally. List natural changes in one column and changes brought about by man in the other. Let the class try to discover your basis for division. Then ask them to read, as a check on their suggestions, the section "Change and More Change." (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activities

1. Make a collection of pictures showing changes in the earth's surface.

2. Read in the *National Geographic Magazine* for February, 1942, pp. 205-34, the story of how the Chinese made the Hwang Ho once more follow its old course as a means of protecting the country.

Study Problems and Exercises

1. Name five agents or forces that tear land down. (*Air, water, ice, volcanism, diastrophism*)

2. Name five agents or forces that build land up. (*Air, water, ice, volcanism, diastrophism*)

3. Which of the processes that bring about changes in the earth's surface do these sections illustrate?

(1) "An Island That Blew Itself Up" (*Volcanism*)
(2) "An Earthquake and a New Shore Line" (*Diastrophism*)
(3) "A River That Changed Its Course" (*Work of water, or erosion and deposition*)

4. What does "Cutting Apart Two Continents" illustrate? (*Man-made change*)

5. What is the "everlasting war" discussed on pages 8 and 9? (*War between land and sea*)

6. What force does the picture on page 9 illustrate? (*Diastrophism*)

VII. The First Round of the Battle (pages 9-12)

Core Ideas

Weathering is the first round in the battle between land and sea.

Weathering is the breaking up of rock so that it can be moved by ice, wind, and water.

Rock is weathered in many different ways.

Possible Approach

Call the attention of the class to the picture on page 2. Ask how the mountains in the picture could be carried to the sea. Let the class check their suggestions by reading the first paragraph of the section. Then ask them to look again at the picture to find signs that the battle for the mountain has begun. Raise the question of how the pieces of rock forming the conspicuous slopes were broken off. Let the class check their suggestions by reading paragraphs 2 to 6 of the section.

Activities

1. Crack a piece of glass tubing by first heating one end of it in the flame of a Bunsen burner and then plunging the hot end into a deep pan filled with cold water. What has this experiment to do with the story of changes in the earth's surface? If you do not know, read again page 10.
2. Examine a lichen growing on rock or bark.
3. Plan a way of showing that water expands when it freezes.
4. Put a little dry soil on a sheet of white paper. Crumble it and spread it out so that the particles are separated from one another. Examine the soil with a magnifying glass. Notice the different sizes of the rock particles.

Study Problems and Exercises

1. Notice the heading in the middle of page 9. What is "the first round of the battle"? (*P. 12, ¶ 3*)

2. Copy and complete this outline:

Weathering includes
a) The breaking up of rock by *(changes in temperature)*.
b) The breaking up of rock by *(freezing water)*.
c) The breaking up of rock by *(trees)*.
d) The breaking up of rock by *(the action of gases in the air)*.
e) The breaking up of rock by *(lichens)*.
f) The breaking up of rock by *(the dissolving of parts of it)*.

3. Make captions, or titles, for the pictures on pages 10, 11, and 12. (P. 10—*Tree Growing on Rocky Slope;* p. 11—*Talus Slopes;* p. 12—*Lichens on Rock*)

VIII. RIVERS AND THE WORK THEY DO (pages 13-18)

Core Ideas

Rivers carry great loads of weathered rock.

Rivers can wear their way down into solid rock if they are carrying sand and gravel.

Because they wear away land, rivers change as they grow older.

Rivers often build up deltas at their mouths.

Rivers both tear down land and build it up; they fight for both the land and the sea.

Possible Approach

Show pictures of the Grand Canyon. Ask how many in the class have seen it. Let those who have tell the others in the class about it. Raise the question of how the Grand Canyon came to be. To check their ideas, ask the class to read the first four paragraphs of the section.

Activities

1. Follow suggestion No. 2 on page 36 of the unitext.
2. Follow suggestion No. 4 on page 36 of the unitext.
3. Make models in clay of a young river valley, a mature river valley, and an old river valley.
4. Make a collection of pictures of rivers. Try to decide in the case of each one whether it is a young river, a mature one, or an old one.
5. Plan an experiment that will show why the ocean is salty.

Study Problems and Exercises

1. Make suitable captions, or titles, for the illustrations on pages 13, 14, 16, 17, and 18. (P. 13—*A Young Valley,* or *The Grand Canyon;* p. 14—*A Young Valley,* or *A V-shaped Valley;* p. 16—*A Mature Valley;* p. 17—*The History of a River;* p. 18—*A City Built on a Delta*)
2. Tell two ways in which you can tell an old valley from a young one. (Young valley: *steep slopes, no flood plain;* old valley: *gentle slopes, wide flood plain*)
3. The speed with which running water wears away land depends on many things. Name three. (*Steepness of slope, amount of water, amount of sand and gravel the water is carrying*)
4. Draw a diagram to show that you understand what a delta is.

5. On which side does running water fight in the war between land and sea? (*P. 18, ¶ 3*)

IX. WATER UNDERGROUND (pages 19-21)

Core Ideas

Water that sinks into the ground may dissolve rock and form caves.

Underground water may come to the surface in springs, wells, or geysers.

Underground water fights on both sides in the war between land and sea.

Possible Approach

Show pictures of Mammoth Cave, the Carlsbad Caverns, and other such caverns. Encourage the class to tell of visits to any large caverns. Lead the pupils to discuss the origin of such caverns and of the stalagmites and stalactites found in them. Let them check their ideas by reading the first seven paragraphs of the section.

Activities

1. Make a collection of pictures of caverns, geysers, and hot springs.

2. If there is a museum near you, perhaps it will have a stalactite or stalagmite which you can examine.

3. Find out what an artesian well is. Plan and set up a demonstration to show how an artesian well works.

Study Problems and Exercises

1. Name two signs you might see of the work of underground water. (*Caves, sinkholes, terraces around hot springs*)

2. Make captions for the sketches on pages 20 and 21. (P. 20—*Stalactites and Stalagmites;* p. 21—*A Geyser*)

3. Draw a diagram to show what causes a geyser to erupt. (*P. 20, ¶ 4*)

4. On which side does underground water fight in the battle between the land and the sea? (*P. 21, ¶ 2*)

X. WIND AND WAVES (pages 21-22)

Core Ideas

Wind moves sand and dust from place to place.

Wind carrying sand wears away solid rock.

Wind piles up waves and causes currents which bring about changes in shore lines.

Wind and waves fight on both sides in the war between land and sea.

Possible Approach

Call attention to the picture on the cover of the unitext. Ask what has brought about the queerly-shaped rock masses the picture shows. Let the class check their conclusions by reading the first paragraph on page 22.

Activities

1. Make a collection of pictures of sand dunes.
2. Find pictures of Chinese villages carved out of loess.
3. Follow suggestion No. 5 on page 36 of the unitext.
4. Many kinds of rock are made of sediments dropped on the ocean floor. They are called "sedimentary rocks." Examine a collection of such rocks.

Study Problems and Exercises

1. Make suitable captions for the pictures on pages 22 and 23. (P. *22—Sand Dunes of Peru;* p. 23—*A Beach Built Up by Waves and Shore Currents*)
2. On which side do wind and waves fight in the battle between land and sea? (*On both sides*)
3. On which page in the book is there a picture showing undercutting? (*P. 34, top picture*) Is the undercutting shown being done by waves or by some other agent? (*Running water*)

XI. Fields and Rivers of Ice (pages 23-26)

Core Ideas

Glaciers are moving fields or rivers of ice.

Glaciers move loose rock material and wear away the solid rock over which they pass.

Glaciers build up deposits called "moraines."

Glaciers fight on both sides in the war between land and sea, but they help the sea most.

Possible Approach

Probably some members of the class will have seen glaciers in Glacier National Park, Mount Rainier National Park, or elsewhere. Let them tell about any experiences they may have had with glaciers. Ask what signs they saw, if any, that glaciers play a part in the battle between land and sea. Let them find out by reading the section what other signs they might have seen.

Activities

1. Make a collection of pictures of glaciers.
2. On pages 34 and 35 of STORIES READ FROM THE ROCKS, another unitext in this series, you will find colored pictures of a glacial boulder and of a piece of rock with glacial scratches on it. Look at these pictures.
3. In STORIES READ FROM THE ROCKS there is a very simple account of the Great Ice Age. Read this account or some similar one.
4. Make a map showing what part of North America was once covered with ice. STORIES READ FROM THE ROCKS or almost any geology textbook will help you.
5. Icebergs interfere greatly with shipping in the North Atlantic. Find out from reference books all that you can about icebergs and their influence on shipping routes.

Study Problems and Exercises

1. Write suitable captions for the pictures on pages 24 and 25. (P. 24—*A Valley Glacier;* p. 25—*A Fiord*)
2. What do we in the United States owe to the glaciers of the Great Ice Age? (*P. 26, ¶ 1*)
3. Suppose the glacier shown in the picture on page 24 should disappear. Name two signs which would show that it had once been there. (*Moraines, large boulders, scratches on rocks, U-shaped valley*)
4. Fill the blanks in this sentence: In the war between land and sea, glaciers help the ___(*sea*)___ more than the ___(*land*)___.

XII. VOLCANOES (pages 26-29)

Core Ideas

Volcanic eruptions both build up land and tear down land.

A volcano builds its own mountain from the lava and ashes it sends out.

Possible Approach

Ask the class to recall the story of the eruption of Krakatoa. Then read with them the first three paragraphs of the section. Discuss the difference, so far as the battle between land and sea is concerned, between the Krakatoa eruption and the Bogoslov eruption.

Activities

1. You can stage a miniature volcanic eruption in this way: Out of modeling clay build a model of a volcanic cone about a foot high. Put a small metal pan in the top of the cone to serve as a crater. Fill the pan with ammonium dichromate. Light the ammonium dichromate with a match. Ammonium dichromate is brilliant orange, but it produces green ashes when it burns. These ashes will pour over the top of the crater and down the sides of the cone. Very fine particles of the green ash will be scattered for several feet.

2. Find in magazines or books stories of some of the world's great volcanic eruptions, e.g., the eruption of Vesuvius that buried Herculaneum and Pompeii.

3. Make a collection of pictures of volcanoes.

4. Many kinds of rock are formed when lava or magma hardens. These kinds of rock are called "igneous rocks." Examine a collection of igneous rocks.

5. Read in an encyclopedia or some other reference book the story of Crater Lake.

Study Problems and Exercises

1. What do the diagrams on page 28 show? (*How a volcano builds its own mountain.*)

2. What is the difference between magma and lava? (*P. 27, ¶¶ 1 and 3*)

XIII. EARTHQUAKES (pages 29-31)

Core Ideas

Earthquakes are common in connection with volcanic eruptions.

Many earthquakes are caused by the slipping of the solid rock of the earth along great cracks in the rock.

Earthquakes are most common in the mountain-building regions of the world.

Possible Approach

Some members of the group may have felt earthquake shocks. If so, let them tell of their experiences. Discuss possible causes of the earthquake shocks they felt. Let the class find by reading the first six paragraphs of the section whether there are causes of earthquakes in addition to those mentioned.

Activities

1. Look for pictures which you can show to the class of damage done by earthquakes.

2. Find in magazines or books stories of famous earthquakes.

3. In almost every college geology book there is a seismograph record of some earthquake. Find and examine one of these records.

4. Make clay models of the fault shown in the diagrams on page 30.

5. Find in the book another diagram of a fault. (*P. 32,* 3rd diagram)

Study Problems and Exercises

1. Name two causes of earthquakes. (*P. 29, ¶¶ 2 and 4*)

2. Make a caption for the set of diagrams on page 30. (*A Fault*)

3. What is a seismograph? (*P. 30, ¶ 4*)

4. Is Chicago in great danger of being damaged by volcanic activity or by earthquakes? Give some basis for your answer. (*P. 31, ¶ 1*)

XIV. Mountain Building (pages 31-34)

Core Ideas

Mountains are built in several different ways.

Folded and faulted mountains are built by the movements we call "diastrophism."

If it were not for diastrophism, the sea would long ago have won the battle between land and sea.

Possible Approach

Read with the class the first four paragraphs of the section. Then let them try to tell how each of the mountains shown in the diagrams on page 32 was made. By reading further they can check their suggestions.

Activities

1. Follow suggestion No. 3 on page 36 of the unitext.

2. Draw diagrams to tell the story of the Appalachian Mountains which is here told in words:

The Story of the Appalachians

The story of the Appalachian Mountains begins many millions of years ago. Until some 200 million years ago there was a great trough in the place where the Appalachians now are. An arm of the sea filled this trough.

Sand and mud were washed down into the trough by rivers. Countless little shelled animals lived and died and left their shells at the bottom of the water. There came to be thick layers of sandy and limy mud on the floor of the trough. In time these layers of sandy and limy mud became solid rock.

About 200 million years ago the bottom of the greater part of the trough began to be pushed up in huge folds. The water from the northernmost part of the trough had been drained away somewhat earlier. Now all the region became dry land. On and on the folding went, and the land rose higher. The change took place slowly, you understand—so slowly that you would not have noticed that any change was going on even if you had lived for years at the very crest of a fold.

As soon as the floor of the trough was pushed up above the land round about, wind and running water began to wear it down. But the folding went on faster than the wearing away. Higher and higher the bottom of the trough was pushed up until there was a mountain system where the trough had been.

The upward push finally stopped, but of course the wearing away did not. The great folds were broken up into mountain peaks by the work of wind and water. Then little by little these peaks were worn down. In 150 million years the region was worn down to almost a flat plain.

Before the wind and water had quite completed their work, however, there was another great movement of the rocks of the region. Again they were pushed up. This time the layers of rocks were pushed up without being folded. Water and wind went on with their work. They carved the high land into mountain ridges and then wore the ridges down almost to a plain. Once again, perhaps several more times, the region was pushed up after a long period of erosion.

Since the last pushing up, wind and water have not yet had time to wear the mountains down to a plain. The story is a continued story. The Appalachians may be pushed up many more times. The pushing up and wearing down of the Appalachians may go on for another 200 million years—perhaps for longer still.

Study Problems and Exercises

1. Make a suitable caption for the set of diagrams on page 32. (*Ways in Which Mountains Are Built*)

2. Read very carefully the paragraph which begins at the bottom of page 33. Give in your own words the main idea of this paragraph. (*Last sentence of paragraph*)

XV. The Story of Niagara Falls (pages 34-36)

Core Ideas

The story of Niagara Falls is a story of the work of running water.

Niagara Falls will continue to retreat.

Possible Approach

Call the attention of the class to the picture of Niagara Falls on page 35. Ask how many of the group have seen the Falls. Tell the class that if, a few thousand years ago, they could have flown over Goat Island, the island shown in the picture, they would have seen no falls at the sides of the island. Ask for an explanation. Let them check by reading the section any explanation they may offer.

Activity

Build a model of clay to show the retreat of Niagara Falls.

Study Problems and Exercises

1. What do the diagrams on page 34 show?

2. Why do people study Niagara Falls to find out how long ago the Great Ice Age was? (*P. 34, ¶ 2; p. 35, ¶ 1*)

3. If a thousand years from now, you could fly over Niagara Falls, what change would you expect to see. (*The Falls will have retreated farther.*)

Summary Exercise

List ten of the important ideas of this unit.

Materials and Equipment

(See page 405)

National Geographic Magazine, Febr. 1942
Glass tubing 4
Bunsen burner or alcohol lamp 4
Deep pan 1
Magnifying glass 4
Large shallow pan 1
Modeling clay 5
Sand pan 5
Electric fan 1
Collections of sedimentary and igneous rocks 4
Stories Read from the Rocks
Small metal pan 5
Ammonium dichromate 4, 3

THE EARTH'S NEAREST NEIGHBOR

(Note general information page 5)

I. Introduction (pages 3-4)

Core Ideas

The moon is the earth's nearest neighbor in space.

The moon shines only by reflected light.

Possible Approach

Give the class copies of The Earth's Nearest Neighbor. Call attention to the title, and ask what the book must be about. Let the class check their answer by turning quickly through the unitext and glancing at pictures and section headings.

Put on the board a dot to stand for the earth. Seven and three-fourths feet away put a dot to stand for the sun (*each foot will then stand for 12,000,000 miles, and each inch for 1,000,000 miles*). Ask some member of the group to put a dot on the board to stand for the moon and to show the comparative distances of the sun and the moon from the earth. If other members of the group have different ideas, encourage them to express their opinions.

Draw on the board a one-inch circle to stand for the earth. Ask some member of the group to draw a circle to stand for the moon and to show how the moon compares with the earth in size. Ask a second member of the group to draw a circle to stand for the sun and to show how the moon compares with the sun in size. Allow the class to comment on the diagrams.

Then have the class check their ideas about the size of the moon and its distance from the earth by reading page 3 of The Earth's Nearest Neighbor. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activities

1. On some night when the moon is full, close one eye and hold a penny at arm's length between your other eye and the moon. How much of the moon does the penny hide? (*All of it*)

2. Make a collection of pictures of the moon. There are often pictures of the moon in newspapers and magazines.

3. You will notice that under every photograph of the moon in The Earth's Nearest Neighbor the name of the observatory at which the photograph was taken is given. What three observatories are named? (*Lick, Mt. Wilson, Yerkes*) Find out what you can about these three famous observatories from encyclopedias. Be ready to report to the class what you find out.

4. Make a clay ball an inch in diameter to stand for the earth. Make a clay ball one-fourth inch in diameter to stand for the moon. Now break the "earth" up into as many "moons" as possible. Doing so will give you some idea of how much larger the earth is than the moon.

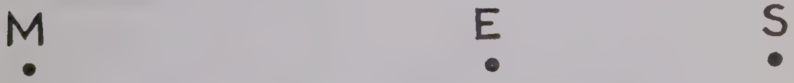
5. If you live in one of the cities in which there is a planetarium, visit the planetarium and find out what you can there about the moon.

Study Problems and Exercises

1. Suppose you were making models of the sun, the earth, and the moon. If you made the moon a fourth of an inch in diameter how large would you make the earth and the sun? (Earth—*1 inch;* sun—*100 inches*)

2. What does the last sentence in paragraph 3, page 3, mean?

3. What is wrong with this diagram so far as the positions of the sun, earth, and moon are concerned? (*Moon is much nearer the earth than is the sun.*)



II. A Visit to the Moon (pages 4-12)

Core Ideas

Conditions on the moon are very different from conditions on earth, largely because of lack of atmosphere and water there.

Life as we know it on the earth could not exist on the moon.

Surface gravity on the moon is much less than on the earth.

Possible Approach

Call attention to the title of the section. Ask the class to tell anything they think they know, before reading the story, about conditions one would find on the moon if he could go there. List the conditions they mention, and save the list for discussion after the class has finished reading the story.

Activity

Look at the picture on the cover of the unitext. What points made in the story does this cover picture illustrate? (*Craters, mountains, black sky, black shadows, earth visible in the sky*)

Study Problems and Exercises

1. Tell ten ways brought out by the story in which conditions on the moon differ from conditions on the earth.

2. How fast must the imaginary machine in the story have been traveling when it escaped from the earth? Reread page 3.

III. MOUNTAINS AND CRATERS ON THE MOON (pages 12-14)

Core Ideas

The light and dark patches on the moon are due to the mountains and plains there.

The many craters on the moon are probably the craters of dead volcanoes.

Although many areas on the moon are called "seas," they are not really seas.

Possible Approach

Show the class the picture of the moon on one of the charts provided to accompany THE EARTH'S NEAREST NEIGHBOR. (This chart may be obtained without charge from the publishers.) Find on the picture of the moon on page 2 of the unitext all the surface features named on the picture on the chart. Call attention to the crater Copernicus. Ask the class from what they know of the size of the moon to estimate the size of this crater. Let them check their ideas by reading the fourth paragraph of this section. (Area of R. I. is 1,248 sq. miles.)

Activities

1. Visit an observatory if possible, and look at the moon through a large telescope. Look for the mountains, craters, and "seas."

2. In some museums there are models of the moon. See one of these models, if there is one in a museum near you.

Study Problems and Exercises

1. If, twenty years from now, a picture were taken of the part of the moon shown on page 11, would you expect to see that many changes had taken place? Why or why not? (*P. 13, ¶ 7*)

2. What are the two ideas about how the craters on the moon were formed? (*P. 13, ¶ 4*)

IV. THE MOON'S MOVEMENTS (pages 15-17)

Core Ideas

The moon travels around the earth as the earth travels around the sun.

The moon rotates on its axis as it travels around the earth.

The moon keeps the same side always toward the earth.

The earth's gravity keeps the moon from moving out into space.

Possible Approach

Call the attention of the class to the diagram on page 16. Ask what it shows. Let the class check any ideas they get from it by reading the first paragraph on page 15 and the third paragraph on page 16.

Activities

1. Follow suggestion No. 2 on page 36 of the unitext.

2. You have probably read stories of rocket ships that reached the moon. Suppose a rocket ship could be made that would go fast enough to enable it to escape from the earth. Let us suppose that it starts at seven miles a second. It would not continue at that speed all the way to the moon. It would lose speed in going against the earth's pull until it was finally traveling at a speed of only about a mile and a half a second. At this rate it would reach the moon in about two days.

The moon in its path around the earth moves about 2,300 miles an hour. About how far would the moon have traveled, then, while the rocket ship was traveling the distance to the moon? (*48 × 2,300 miles, or 110,400 miles*) You see now that it would not be easy for a rocket ship to reach the moon even if a rocket ship that would travel 250,000 miles away from the earth could be made.

Study Problems and Exercises

1. In one of the large museums in this country there is an excellent model of the moon, but it is a model of only one half of the moon. What reason can you see for making a model of only one half of the moon? (*P. 16, ¶ 4*)

2. Why does the moon neither fall to the earth nor run away from it? (*P. 16, ¶¶ 1 and 2*)

V. WHY THE MOON CHANGES SHAPE; VI. STORIES OF THE MOON'S PHASES (pages 17-23)

Core Ideas

The phases of the moon are due to changes in the relative positions of the earth, the sun, and the moon.

The time from one new moon to the next is about 29½ days.

The time of the rising and the setting of the moon varies from day to day.

In olden times people made up stories to explain the moon's phases because they did not know the real explanation of these phases.

Possible Approach

Ask some member of the group to draw on the board a diagram showing how the moon looked the night before. If there is disagreement as to the apparent shape of the moon, consult an almanac and find out in what phase the moon was. Discuss the problem of why the moon does not always look the same. Let the class check their conclusions by reading the first three pages of the section.

Activities

1. Follow suggestion No. 1 on page 36 of the unitext.
2. Follow suggestion No. 3 on page 36 of the unitext.
3. Follow suggestion No. 4 on page 36 of the unitext.
4. Keep a record of the phases of the moon on the chart provided for that purpose. (This chart may be obtained without charge from the publishers.) On the same chart keep as full a record as possible of the time of the rising and setting of the moon. Usually in connection with weather reports in the newspapers either the rising time or the setting time is given.

5. Find out how old the moon is tonight. Then draw a diagram showing the relative positions of the earth, the sun, and the moon tonight.

Study Problems and Exercises

1. Draw three diagrams showing the relative positions of the earth, the sun, and the moon:

a) When the picture on page 2 was taken.
b) When the picture on page 15 was taken.
c) When the picture on page 19 was taken.

2. The picture on page 15 was taken at Yerkes Observatory at Williams Bay, Wisconsin. Could it have been taken at midnight? Why or why not? (*No—see p. 21, ¶ 2.*)

3. Why could you never see a star between the horns of the crescent moon? (*No star is closer to us than the moon. Seeing a star between the horns of the crescent moon would mean seeing through the unlighted part of the moon.*)

4. Explain the picture on page 22. (*P. 22, ¶ 3*)

5. Myths like those told on page 23 are sometimes called the beginning of science. Why? (*People were trying to explain what they saw happening around them.*)

6. Explain *A* in the series of pictures on page 20. (*P. 18, ¶ 3*)

VII. THE MOON AND THE TIDES (pages 24-27)

Core Ideas

Tides are caused by the moon.

Sometimes the sun and the moon pulling together on one part of the earth's surface cause the tides to be very high.

Tides are important not only to seamen but to all people who live near the ocean shores.

Possible Approach

Ask the class to look at the pictures at the tops of pages 24 and 25. What do the pictures show? Why should they be in a book about the moon? Let the class check their suggestions by reading the first four paragraphs of "The Moon and the Tides."

Activities

1. If you live near a seacoast, find out when the tides will be high each day for a week.

2. For fun, read in Kipling's *Just So Stories* "The Crab That Played with the Sea," a story of the tides.

Study Problems and Exercises

1. Choose the correct answers and underline them:

a) If there was high tide at a certain place on the coast at 5:00 A.M. today, the next high tide would be at about (*See p. 25, ¶ 3.*)

10:00 P.M. today   *5:25* P.M. *today*   11:30 A.M. tomorrow

b) If there was high tide at 10:00 A.M. today, the first high tide tomorrow would be at about (*See p. 25, ¶ 4.*)

11:00 A.M.   9:00 A.M.   2:00 P.M.

2. Draw a diagram showing the relative positions of the sun, the earth, and the moon at the time of the moon's first quarter. At this phase of the moon are the sun and the moon pulling up tides at the same places on the earth at the same time? (*No*)

3. Write a title for the diagram at the top of page 26. (*Sun and moon causing tides at the same places at the same time*)

VIII. ECLIPSES; IX. FAMOUS ECLIPSES (pages 27-32)

Core Ideas

The moon is eclipsed when it passes into the earth's shadow.

The sun is eclipsed when the moon throws its shadow on the earth.

An eclipse of the moon can occur only when the moon is full.

An eclipse of the sun can occur only at the time of the new moon.

The people of earlier times were much terrified by eclipses.

Possible Approach

Use a clay ball half an inch in diameter to stand for the moon. The clay, if possible, should be pale yellow or white. Use a clay ball two inches in diameter to stand for the earth. Use a flashlight (or a desk lamp) to stand for the sun. Put each ball on the end of a steel knitting needle (or some other similar rod that is strong enough to support the weight of the ball). Hold the "moon" and the "earth," by means of the knitting needles, so that the shadow of the "moon" falls on the "earth." Call attention to the fact that the shadow does not cover the whole earth. Hold the moon so that the earth's shadow falls on the moon. Notice that the earth's shadow is large enough to cover the whole moon. Explain the term "eclipses," and raise the question, as a motivation for further reading, of why there is not an eclipse of the moon at the time of every full moon.

Activities

1. To get a description of a total eclipse of the sun and of the work astronomers do in preparing for a total eclipse, read the following articles in the *National Geographic Magazine:*

F. A. Mitchell, "Nature's Most Dramatic Spectacle" (September, 1937).

J. F. Hellweg, "Eclipse Adventures on a Desert Isle" (September, 1937).

Irvine C. Gardner, "Crusoes on Canton Island" (June, 1938).

2. For fun, read the first six chapters of *A Connecticut Yankee in King Arthur's Court* by Mark Twain. In these chapters you will find the story of how an eclipse of the sun saved the life of the Yankee.

3. With a flashlight and two clay balls to stand for the earth and moon, show why there is not an eclipse of the sun every time there is a new moon. (*P. 29, ¶ 5*) Show, too, why there is not an eclipse of the moon every time there is a full moon. (*P. 28, ¶ 3*)

4. Cut out a circle of cardboard about three inches across. Move it between your eyes and a lighted electric-lamp bulb. You can move it in such a way that you cannot see the lamp at all. The card shuts off the light of the lamp from your eyes. It throws a shadow on your eyes and causes a total eclipse of the lamp.

Now lower or raise the card and move it between your eyes and the lamp in such a way that only a part of the lamp is hidden. The card has caused a partial eclipse of the lamp.

You can see for yourself how total and partial eclipses of the sun are caused. What does the electric lamp stand for? (*Sun*) What does the cardboard circle stand for? (*Moon*)

5. Find out from an almanac the number of eclipses of the moon this year. Find out, too, the number of eclipses of the sun, if any, in your locality.

6. By looking at almanacs of various years, try to find a year in which there were no eclipses of the moon.

Study Problems and Exercises

1. Write a title for the diagram at the bottom of page 27. (*An eclipse of the moon*) Write one for the diagram at the top of page 28. (*An eclipse of the sun*)

2. Draw a diagram showing the relative positions of the earth, sun, and moon at the time of an eclipse of the moon.

3. Draw a diagram showing the relative positions of the earth, sun, and moon at the time of an eclipse of the sun.

4. What picture on page 20 shows how the moon would look just before it was eclipsed? (*E*)

5. What picture on page 20 shows how the moon would look just before an eclipse of the sun? (*A*)

6. Total eclipses of the moon do not occur so often as do total eclipses of the sun. Why, then, have so many more people seen total eclipses of the moon than have seen total eclipses of the sun? (*P. 28, ¶ 2; p. 29, ¶ 4*)

7. Why is there not an eclipse of the moon every time the moon is full? (*P. 28, ¶ 3*)

8. Would you agree with this statement?

"Eclipses are not important."

Explain your answer. (*They played an important part in early history. Now they are important chiefly because they give astronomers a good chance to study the sun and moon.*)

X. THE MOON AND THE CALENDAR (page 33)

Core Ideas

The moon has for centuries helped people measure time.

Our months, however, are not true moon months.

Possible Approach

Show the class an almanac or a calendar on which the phases of the moon are marked. Let them find the date of the full moon this month and the dates of the full moons in the two preceding months and in the two succeeding ones. Raise the question of whether our months are really "moons." Let the class check their ideas by reading the first two paragraphs of "The Moon and the Calendar."

Activities

1. Follow suggestion No. 5 on page 36 of the unitext.

2. If you have almanacs of several different years, try to find a month in which there were two full moons. Try to find a year in which there were thirteen full moons.

Study Problems and Exercises

1. Why have we given up true moon months? (*P. 33, ¶ 2*)

2. In a certain year there was no full moon in February. The year was not a leap year. You should be able to give the dates of one full moon in January and one in March. What were they? (*January 31; March 1*)

XI. MOON SUPERSTITIONS (pages 33-35)

Core Idea

There are many unfounded beliefs about the influence of the moon on crops, the weather, and the fortunes of the people of the earth.

Possible Approach

Write on the board some of the common beliefs about the moon and its effect on the earth. Ask the class to tell which beliefs they think are well founded and which are not well founded. Let them check their conclusions by reading "Moon Superstitions."

Activity

Keep a record of any moon superstitions that you hear mentioned. Try to find out whether there is any foundation for them.

Study Problems and Exercises

1. Choose any one of the superstitions you are told about on pages 33-35. How would you go about finding out for yourself that it is just a superstition?

2. Tell three ways in which the moon helps people. (*Causes tides, lights up earth at night, helps primitive people measure time, makes night sky beautiful*)

Summary Exercise

Mark each of the following sentences "True" or "False."

C (1) The moon shines because it reflects some of the sunlight which falls on it.

X (2) The moon is larger than the sun.

C (3) A person who weighs 120 pounds on the earth would weigh only 20 pounds on the moon.

C (4) The moon turns on its axis once as it travels around the earth.

X (5) If the shadow of the earth never fell on the moon, the moon would always be full.

C (6) The phases of the moon are caused by the movement of the moon around the earth.

X (7) The moon always rises at the same time.

C (8) Both the sun and the moon cause tides.

C (9) At any one time there are two high tides.

X (10) At any one place on the coast high tides come at the same times every day.

C (11) An eclipse of the moon occurs when the moon gets into the earth's shadow.

X (12) An eclipse of the sun occurs when the sun gets into the earth's shadow.

X (13) All astronomers are sure that the craters on the moon are the craters of "dead" volcanoes.

X (14) The great plains of the moon are much brighter than the mountainous regions of the moon.

C (15) Eclipses can be predicted many years in advance.

X (16) When there is a total eclipse of the sun, it can be seen over the whole world.

C (17) There are more than twelve and less than thirteen true moon months in a year.

X (18) The full moon always occurs on the same day of the month.

X (19) A change in the moon always brings a change in the weather.

X (20) We get almost as much light from the moon in the course of a year as we get from the sun.

Materials and Equipment

(See page 405)

2 moon charts (can be obtained without charge from publisher)
Almanacs of various years, including the current year 3
2 steel knitting needles
Flashlight or desk lamp
Modeling clay (yellow and gray) 5
Cardboard 5

FIRE, FRIEND AND FOE

(Note general information page 5)

I. Introduction (page 3)

Core Idea

Men have long known of the importance of fire, but not until recently have they found out what fire is.

Possible Approach

Ask each member of the class to list ten nonliving things in the classroom. Then ask each person to cross off his list everything in the making of which fire had something to do. Make a composite list on the board of the items left on the various individual lists. Discuss the significance of the shortness of the composite list. Light a candle. Ask someone in the class to tell exactly what is happening as the candle burns. Use his attempt, which is likely to be unsuccessful, to bring out the fact that it is much easier to recognize the importance of fire than to tell what fire is. Give the class copies of Fire, Friend and Foe, and ask them to find out from page 3 whether the people of early times recognized the importance of fire and whether they could explain what fire is. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activity

Burn in a metal pan a small pile of paste sticks. Notice what is left in the pan after the paste sticks have burned up. Burn in the pan a tablespoonful of ammonium dichromate. Notice what is left in the pan after the ammonium dichromate has stopped burning. What puzzles you about the results? You will find later the explanation of the difference in results. (As is pointed out in the section, "The Role of Oxygen," *the products of burning may be gases, liquids, or solids. Ammonium dichromate when it burns produces a great amount of a green solid—chromic oxide; wood when it burns produces chiefly water vapor and carbon dioxide, which are both gases. These gases escape into the air. Wood leaves behind as ashes the minerals it contained.*)

Study Problems and Exercises

1. What wrong idea did the ancient Greeks have about fire? (*P. 3, ¶ 3*) Can you, by thinking of a burning candle, account in any way for their thinking of fire as a material? (*A flame looks like a substance escaping from a candle, and the candle gets smaller.*)

2. Name three ways in which fire helped our primitive ancestors. (*P. 3, ¶ 2*)

II. WHAT IS FIRE? (pages 4-5)

Core Ideas

Fire is a chemical change which produces light and noticeable heat.

A chemical change is a change which results in the formation of new materials, as distinguished from a physical change, in which no new materials are formed.

Possible Approach

Break up a paste stick into tiny pieces. Burn another paste stick. Point out that in both cases the paste stick is gone. Raise the questions: Is there any difference in the kind of change that has taken place in the two cases? Burning is what kind of change? Have the class check their conclusions by reading paragraphs 1 and 2 of the section, "What Is Fire?"

Activities

1. Heat a piece of fine wire red-hot by holding it so that it touches the two posts of a dry cell. The wire is not burning although it is red-hot.

2. Stand a candle on one side of a pair of platform balances. Balance the candle with weights. Light the candle and let it burn for several minutes. Notice the change which takes place in the candle's weight.

3. Get a large, wide-mouthed bottle. Pour a little limewater into the bottle. Shake it around. Notice that it is still clear. Lower a lighted candle into the bottle. Let it burn there for a minute or two. Then remove it and shake the limewater around again. The milky color of the limewater shows the presence of carbon dioxide in the bottle. Where must it have come from? (*Carbon dioxide is one of the products of the burning of paraffin.*)

4. Hold a cold bell jar (or large wide-mouthed bottle) over an unlighted candle. Notice that the inner walls of the bell jar remain clear. Hold the bell jar over a lighted candle. Notice the moisture which appears on the inner walls of the bell jar. Where must it have come from? (*Water vapor is one of the products of the burning of paraffin. When the water vapor touches the cold bell jar, some of it condenses.*)

5. The pictures on page 4 of the unitext show two examples of physical change. Show the class another example of such change.

6. Light a stick of charcoal. Notice that it burns without a flame.

Study Problems and Exercises

1. Divide the following items into two groups. Use some fact or principle we have discussed in this unit as a basis for your division. Write the items in two columns and show by your headings what your basis for division is.

1) The rusting of iron (C)
2) The souring of milk (C)
3) The evaporation of a puddle of water (P)
4) The dissolving of sugar in water (P)
5) The peeling of a potato (P)
6) The breaking of a stick in two (P)
7) The weaving of rags into a rug (P)
8) The grinding of a pound of coffee (P)
9) The burning of a piece of paper (C)
10) The explosion of a firecracker (C)

2. Tell in one sentence the most important idea in the section, "What Is Fire?" (*Combustion, or fire, or burning, is a chemical change which produces light and noticeable heat.*)

III. THE REQUIREMENTS FOR FIRE (pages 5-6)

Core Idea

The three requirements for fire are: (1) a material which will burn, (2) a supply of oxygen, and (3) heat enough to bring the material up to its kindling temperature.

Possible Approach

Remind the class that paper burns. Then ask why the paper in their notebooks is not on fire. Check their conclusions by reading the paragraph beginning at the bottom of page 5 of the unitext.

Activities

1. Follow activity No. 6 on page 112 of this manual.

2. Wet the inside of a wide-mouthed bottle. Sprinkle iron filings in the bottle. Turn the bottle upside down and lower it into a shallow bowl (or pan) full of water. The iron will rust in the course of a day or so and will use up the oxygen from the air in the bottle as it does so. Water will rise in the bottle to take the place of the oxygen. After the water has risen in the bottle, slip a plate of glass under the mouth of the bottle and, holding the plate of glass on tightly, turn the bottle right side up. Lower a lighted candle into the bottle. What happens? Why? (*The candle goes out because the oxygen in the air in the bottle has been used up by the rusting of the iron.*)

3. Follow the suggestion given under Possible Approach at the bottom of page 113 of this manual. Phosphorus, you see, has a low kindling temperature.

4. Light a candle. Lower it into a tall, slender graduate with straight sides (or a straight-sided lamp chimney). If the graduate is slender enough, the candle will go out even though you do not close the top. The candle flame does not get the supply of oxygen it must have. Now cut a strip of cardboard a foot long and just the width of the inside diameter of the graduate. Light the candle again and lower it slowly into the graduate. At the same time push the strip of cardboard down into the graduate for a few inches. Be careful not to let it get close enough to the candle flame to catch on fire. The candle should keep on burning because now there is a circulation of air. The fresh air comes down one side of the cardboard, and the hot air from which the oxygen

has been taken is pushed up the other side.

5. Rest a piece of sheet iron on a stand over a Bunsen burner. Put a few small pieces of paper on the piece of iron. Light the Bunsen burner. Let the flame strike the underside of the sheet of iron, but be sure that it does not come up around the iron and strike the paper. Although the flame does not strike it, the paper will catch on fire after the iron gets very hot. Is it flame or heat which is needed to set paper on fire? (*Heat*)

Study Problems and Exercises

1. In each of these cases one of the three requirements for fire was lacking. Tell in each case which one it was.

a) The filaments of early electric-lamp bulbs were made of carbon. Carbon burns easily. Why, then, did the filaments not burn when they became white-hot? (*Oxygen was lacking—the air had been pumped out of the bulbs.*)

b) A shipwrecked mariner found himself on a desert island. He had rescued some matches, but even so he could not build a campfire or a signal fire. (*A material which would burn was lacking.*)

c) Mr. Jones put a few bits of paper and a few sticks of kindling in his furnace and lighted them. Then he put several big lumps of coal in the furnace. The coal did not catch on fire, and the fire went out. (*The fuel was not raised to its kindling temperature—a sufficient supply of heat was lacking.*)

2. Arrange these materials in the order of their kindling temperatures, with the one with the lowest kindling temperature first:

(1)	(2)	(3)
phosphorus	paper	hard coal

IV. Making a Fire (pages 7-9)

Core Ideas

In the building of a fire, provision must be made for a continuous supply of oxygen.

Materials with a low kindling temperature may be used to start materials with a high kindling temperature to burning.

Fire may be started in several ways.

Before the days of matches, fire-making was so difficult that people often preferred to go a long way to get fire rather than to start it anew.

Possible Approach

If any members of the class are Boy Scouts, ask one of them to tell how to build a campfire.

Activities

1. Follow the suggestion given under Activity on page 113 of this manual.
2. Follow suggestion No. 1 under Activities on page 111 of this manual.
3. Follow suggestion No. 2 under Activities on page 111 of this manual.
4. If there is a museum near you, visit it to see whether it has on display some of the primitive devices for making fire.
5. Try to start a fire with a fire drill of the kind Boy Scouts use.
6. Try to get sparks by striking a piece of flint and a piece of steel together.

Study Problems and Exercises

1. List two ways in which fires were started before men learned how to start fires. (*P. 8, ¶ 1*)
2. List five ways in which you could start a fire. (*P. 7, ¶ 5; p. 8, ¶¶ 2 and 3*)
3. Paper burns easily. It is, however, very difficult to burn up a big catalogue or telephone directory in a bonfire. Why? (*The pages fit so closely together that there is not enough room for air between them.*)

V. The Story of Matches (pages 9-12)

Core Ideas

Friction matches are a modern invention.

Matches in general contain a material with a low kindling temperature and a chemical which gives off oxygen when heated.

Possible Approach

Show the class matches of different sizes and kinds. Have members of the class try to strike one of each kind on a piece of sandpaper. Find out in this way which are strike-anywhere matches and which are safety matches. Ask the class to read paragraphs 5, 6, and 7 on page 11 of the unitext to find the chief difference between these two kinds.

Activities

1. Make a sulphur match of the kind the Romans used. Try to light it by friction. You will find that it is not a true friction match.

2. Light a match. Watch it burn. Notice the liquid on the match stick. Find out from page 11 of the unitext what it is.

3. Light a paste stick. Blow out the flame. Look at the stick. Light a match. Blow out the flame. Look at the stick. What is the difference between the two? Page 11 of the unitext explains the difference that you see.

Study Problems and Exercises

1. Why can you not light a safety match on a piece of ordinary sandpaper? (*On ordinary sandpaper there is no phosphorus sulphide to catch on fire and set the head of the match on fire.*)

2. In what important way are the strike-anywhere matches of today like the first true matches? (*The heads contain a chemical that gives off oxygen when heated.*) In what important way are they different? (*The head of a strike-anywhere match contains phosphorus sulphide, which is very easy to set on fire. Heads of first true matches did not.*)

VI. Regulating a Fire (pages 12-14)

Core Ideas

A fire makes its own circulation of air.

The two main ways of regulating a fire are: (1) changing the amount of air furnished to the fire, and (2) changing the amount of fuel furnished to the fire.

Possible Approach

Examine a Bunsen burner to find out where the gas enters the burner and where the air enters it. Put equal amounts of water in three beakers which are just alike. Light the Bunsen burner. Open the air vent wide and turn the gas on full. Use the flame to heat the water in one of the beakers. Find out how long it takes this flame to heat the water to boiling. Turn down the gas so that the flame is noticeably smaller than before. Find out how long it takes this flame to heat the water in the second beaker to boiling. Turn the gas on full once more, but close the air vent. How long does it take the resulting flame to heat the water in the third beaker to boiling? Discuss with the class the two ways in which the flame of the Bunsen burner may be regulated. Let them check by reading the first paragraph of "Regulating a Fire." Decide which way seems to be the better way in the case of the Bunsen burner.

Activities

1. Examine these devices or diagrams of them: a kerosene lamp, an oil-burning furnace, a coal stove, an open fireplace, a coal furnace, a kerosene stove, and a gas stove. Find out how the fire in each one is regulated.

2. Stand a candle up on a table. Light the candle. Put a lamp chimney around the candle. Plan some way of holding the bottom of the lamp chimney up a little way from the table so that there is plenty of room for air to get into the chimney. Rest a plate of glass on the top of the chimney. The candle will go out, because more air cannot enter the chimney unless the hot air from which the oxygen has been used has some way of getting out.

3. Probably there is a thermostat in your schoolroom. If possible, have the janitor or engineer open it and show you how it works.

Study Problems and Exercises

1. What kind of stove is used in your home for cooking? How can it be regulated so that it will give the amount of heat needed?

2. At A a forest fire is burning. B is two miles east of A. There is at B a strong wind caused by the fire. In what direction is it blowing? (*It is blowing from east to west.*)

VII. THE ROLE OF OXYGEN (pages 14-18)

Core Ideas

Oxygen is one of the 92 elements, or simple substances, out of which all substances are made.

The combining of a substance with oxygen is called "oxidation."

Burning is oxidation rapid enough to produce light and noticeable heat.

When substances burn, oxides are produced.

It would be unfortunate if the air were pure oxygen.

Possible Approach

Fill a small porcelain crucible with broken-up bits of wood. Weigh the crucible filled with wood. Then heat it in the flame of a Bunsen burner until all the wood has burned. Weigh the crucible again. Call the attention of the class to the loss in weight.

Now fill another crucible with bits of magnesium ribbon. Weigh the crucible. Heat the crucible in the flame of a Bunsen burner until all the magnesium has burned. Weigh the crucible again. Call attention to the gain in weight. Ask for explanations. Let the class check their conclusions by reading "The Role of Oxygen."

Activities

1. Follow suggestion No. 1 on page 35 of the unitext.
2. Make a collection of oxides.
3. Fill a flask almost full of water. Boil the water for several minutes. Drop two or three clean nails into the flask. Stopper the flask.

Fill a second flask with water, but do not boil the water. Drop two or three clean nails into the flask, but do not stopper the flask. Watch the nails in both flasks for any sign of change. Try to explain any difference you notice between the nails in the two flasks. (*The nails in the boiled water will not rust, because no free oxygen is present. Those in the unboiled water will rust: there is air—and therefore oxygen—dissolved in the water.*)

Study Problems and Exercises

1. List the following materials in three columns under the headings, "Elements," "Compounds," and "Mixtures":

iron (E)
oxygen (E)
magnesium oxide (C)
water (C)
iron rust (C)
hydrogen (E)
air (M)
carbon dioxide (C)

2. Copy exactly the sentence which you consider the most important sentence in "The Role of Oxygen."
(*P. 18—"Burning is oxidation rapid enough to produce light and noticeable heat."*)

3. In what way is the decaying of a log like the burning of a log? (*Both are oxidation.*) In what ways is it different? (*In decaying, oxidation goes on too slowly to give off light and noticeable heat.*)

4. Fill in the blanks in the following:
"Carbon, a solid, in burning unites with oxygen, a gas, to form ______ *(carbon dioxide)* ______, a ______ *(gas)* ______."

5. Describe as "slow" or "rapid" the examples of oxidation pictured on pages 16 and 17. (Exploding firecrackers—*rapid;* runners—*slow;* train—*rapid.*)

VIII. A CANDLE FLAME (pages 18-22)

Core Ideas

A candle flame is a gas flame.

All flames are made of burning gas.

Those materials which do not burn with a flame do not change to gas when they are heated.

There are two zones in a candle flame—one in which the gas from the candle is burning, and one in which the gas is not yet burning.

Soot is unburned carbon.

A candle disappears when it burns, because the products—carbon dioxide and water vapor—are invisible gases.

Possible Approach

Light a candle. Let it burn for a minute or so. Then blow out the candle and relight it by holding a lighted match half an inch above the candle wick. Ask for explanations of why the candle can be lighted in this way. Have the class check their conclusions by reading the last paragraph on page 19 of the unitext.

Activities

1. Try to set fire to the solid paraffin of a candle with a lighted match. What purpose does the wick of a candle serve? (*P. 19, ¶ 2*)
2. Hold a piece of paper horizontally. Lower it quickly into a candle flame until it touches the wick. Lift it up again before it catches fire. Notice the grease spot on the paper. This is made by liquid paraffin from the wick.
3. Notice the two zones in a Bunsen burner flame. Hold a rod of hard wood, such as a dowel rod, through the flame about half an inch above the top of the burner. How can you tell from the dowel rod that the gas in the inner zone is not burning?
4. Follow suggestion No. 5 on page 35 of the unitext.
5. Follow suggestion No. 6 on pages 35 and 36 of the unitext.
6. Fill a beaker with cold water. Light a Bunsen burner and put it under the beaker. Watch moisture appear on the outside of the beaker. Where does it come from? (*It is formed in the flame as water vapor and then condenses on the cold glass.*)

Study Problems and Exercises

1. Fill in the blanks below:

“Paraffin, a solid, breaks up into *(hydrogen)*, a gas, and *(carbon)*, a *(solid)*.”

“The *(carbon)* unites with oxygen to form carbon dioxide, a *(gas)*.”

“The *(hydrogen)* unites with oxygen to form water vapor, a *(gas)*.”

2. Explain exactly why a candle loses weight as it burns. *(P. 20, ¶ 4)*

3. Two boys were working with a Bunsen burner flame. They were heating water in a test tube and were eager to heat it to boiling as soon as possible. “We must hold it down as close to the top of the Bunsen burner as we can,” said the first boy. “No,” said the second, “the upper part of the flame is hotter.” Which one was right? Why? *(P. 20, ¶¶ 1 and 2)*

4. Draw a diagram of a Bunsen burner flame similar to the diagram of a candle flame on page 26 of the unitext.

5. Why should one never let a car motor run in a closed garage? *(P. 22, ¶ 1)*

6. How does the air that goes up a chimney from a furnace fire differ from the air that enters the furnace? *(Warmer, contains less oxygen, contains more carbon dioxide and water vapor, may contain soot.)*

IX. What Materials Will Burn? (pages 22-23)

Core Ideas

Combustible materials are materials that will burn in ordinary air.

All fuels are combustible materials, but not all combustible materials are good fuels.

Possible Approach

Ask the class to name any ten materials. As the materials are named, list them in two columns. In one column list the combustible materials, and in the other column the incombustible materials. Ask the class to determine the basis for the classification. Discuss reasons why the incombustible materials listed will not burn. Have the class check by reading page 23 of the unitext.

Activities

1. Try to burn some threads of asbestos in the flame of a Bunsen burner.

2. Write a name in "fire ink" (a concentrated solution of potassium nitrate in water) on a sheet of paper. Let it get thoroughly dry. Light the ink with a stick of glowing charcoal and watch it burn.

Study Problems and Exercises

1. Explain why asbestos, mercury, and nitrogen will not burn. (*P. 23, ¶ 1*)

2. Divide the following items into two groups on the basis of some idea you have gained in this unit.

glass
paper
kerosene
iron
asbestos
straw
water
oxygen
wood
china

(Combustible: *paper, kerosene, straw, wood.*
Incombustible: *glass, iron, asbestos, water, china, oxygen.*)

3. Name some material which burns readily but which is not a good fuel. Tell why it is not.

X. Our Fuels (pages 24-28)

Core Ideas

A good fuel is a combustible material which (1) is plentiful and fairly cheap, (2) gives off a great deal of heat when it burns, and (3) is safe to use if handled properly.

Different fuels have different advantages.

Activities

1. Follow suggestion No. 9 on page 36 of the unitext.

2. Follow the same plan in heating wood to obtain gas and charcoal. Burn some of the charcoal produced.

3. Put two tablespoonfuls of alcohol in a flask half-full of water. Insert a delivery tube in a one-holed rubber stopper which fits the flask. Put the end of the delivery tube in a test tube standing in a beaker full of cold water. Boil the mixture in the flask for a few minutes. The alcohol will change to vapor before the water reaches its boiling point. The alcohol vapor will go through the tube and change back to liquid alcohol in the test tube. When there is a spoonful or so of liquid in the test tube, pour it out in a metal pan and try to light it. This experiment will help you understand how petroleum is separated into its parts.

4. Perhaps there is a museum near you in which there are models of oil wells and coal mines. See any such exhibits that you can.

Study Problems and Exercises

1. What kind of fuel is used for heating your home? Name as many advantages and disadvantages of this fuel as you can.

2. Tell what happens, as it burns, to the fuel you use.

3. Smoke costs the people of the United States about $500,000,000 a year. List as many as you can of the ways in which smoke adds to the cost of living.

4. Divide the following items into two groups (*fuels, non-fuels*) on the basis of some idea you have gained in connection with this unit.

kerosene (F)
natural gas (F)
mahogany (N)
silk (N)
paper (N)
coke (F)
hard coal (F)
peat (F)
walnuts (N)
sugar (N)

5. Mark each of the following sentences "True" or "False."

C (1) A chemical change is a change resulting in the formation of one or more new materials.
C (2) Burning is a chemical change which produces heat and light.
C (3) Burning is rapid oxidation.
C (4) Black smoke means wasted fuel.
C (5) Fuels which change wholly or in part to gas when they burn, burn with a flame.
X (6) Every combustible material is a good fuel.
C (7) Every good fuel is a combustible material.
X (8) All materials have the same kindling temperature.
X (9) About four-fifths of the air is oxygen.
X (10) It would be very fortunate if the air were pure oxygen.

6. What conclusions can you draw from the chart on the inside front cover? (*Gasoline gives more heat per pound than any other fuel represented in the upper chart. Natural gas gives more heat per cubic foot than any other gas represented in the lower chart.*)

XI. Fire as a Friend (pages 28-30)

Core Idea

Fire is very important in the home, in transportation, and in manufacturing.

Possible Approach

Tell the story of a knife blade, emphasizing the part which fire played in its making.

Activities

1. Follow suggestion No. 1 under Activities on page 109 of this manual.

2. Obtain mercury from mercuric oxide by heating a small amount of mercuric oxide in a test tube in the flame of a Bunsen burner. Obtaining mercury in this way will help you understand the part fire plays in getting metals from their ores.

Study Problems and Exercises

1. Find at least ten ways in which fire plays a part in the making and running of an automobile.

2. Make a list of ten articles which are made in part by the use of fire.

XII. Fire as a Foe (pages 30-32)

Core Ideas

Each year fires out of control cause an enormous loss of life and property.

Most disastrous fires are caused by carelessness.

Possible Approach

Display and lead the class to discuss a chart showing the causes of the destructive fires which occurred in Chicago during a given one-month period. (This chart may be obtained without charge from the publishers.)

Display and discuss a chart showing the amount of damage done by fire in the country as a whole during each of the past twenty years. (This chart would have to be made by the teacher or pupils from statistics from some such publication as *The World Almanac.*)

Activities

1. Tell the class of any experiences you have had with destructive fires. Discuss as fully as you can the causes of the fires.

2. If necessary data are available in daily papers or elsewhere, make a chart showing the causes of the disastrous fires which occurred during a given period in your town or city.

3. Collect newspaper clippings about disastrous fires.

Study Problems and Exercises

1. On the basis of the chart you made, list the five most important rules on page 32 of the unitext.

2. Make five rules for fire prevention in addition to those in the unitext.

3. Explain in your own words what spontaneous combustion is.

XIII. FIGHTING FIRE (pages 33-34)

Core Idea

The chief ways of fighting destructive fires are: (1) shutting off the supply of oxygen, and (2) cooling the burning substance below its kindling temperature.

Possible Approach

In a metal pan build a small fire. (Paste sticks make a satisfactory fire.) Ask some member of the class to put it out. Discuss other ways that might have been used. Build a succession of fires, and test all the ways suggested which the class agrees might work well. Discuss the science back of various ways used. Look in the text to see whether any other suggestions are made there.

Activities

1. Examine any fire extinguishers that are available. Look at the diagrams of fire extinguishers on the inside back cover of the unitext. Find out by reading pages 33 and 34 how these various extinguishers work.

2. Put out a candle flame with a candle snuffer.

3. Put out a candle flame by smothering it with a piece of heavy woolen cloth.

4. Put out a burning match by shaking it.

5. Pour a little carbon tetrachloride into a wide-mouthed bottle. Shake it around in the bottle. Lower a lighted candle into the bottle.

6. Follow suggestion No. 7 on page 36 of the unitext.

7. Follow suggestion No. 8 on page 36 of the unitext.

8. Make a fire extinguisher like the homemade extinguisher diagramed on the inside back cover of the unitext. Use it to put out a small fire.

9. Follow suggestion No. 10 on page 36 of the unitext.

10. Visit a fire department station if possible.

Study Problems and Exercises

1. List three kinds of hand-operated fire extinguishers. Tell about each one: (1) what forces the liquid out of the extinguisher, (2) in what way the extinguisher puts out fires, and (3) for what kinds of fires the extinguisher is supposed to be used. (*P. 33, ¶ 4; p. 34, ¶¶ 1 and 2*)

2. What should you do: (1) if your clothing catches on fire? (2) if you are the first person to see a house on fire? (3) if you find that the decorators have left a pile of oily rags in a corner of a room in which they have been working?

Summary Exercises

1. As a summary of the unit, write in full sentences and in your own words 15 of the important ideas of the unit.

2. Make a list of ten important, or "key," words of the unit. Show by using each one in a sentence that you understand what they mean.

Materials and Equipment

(See page 405)

Bell jar 4
Asbestos mat 1
Convex lens (or reading glass) 4
3 beakers (or pans) of exactly the same size 4
Large, wide-mouthed glass bottle or jar 1, 4
Bunsen burner 4
Candle snuffer 1
Flat cork 3
Electric heater or stove 1
Porcelain crucible 4
3-cornered file 1
Long-handled forceps (or tongs) 1, 4
Plate of glass 1, 4
Tall graduate with straight sides (or lamp chimney with straight sides) 4
Sheet iron 1
Lamp chimney 4
Large shallow pan (or bowl) 1
Small metal pan 1
Platform balances and weights 4
Pyrex test tubes 4
2 flasks 4
Stopper to fit flask 4
Chart designed to accompany unit
Saucer
Tumbler
Rubber tubing for delivery tube 4
1-holed rubber stopper to fit Pyrex test tubes 4
Iron picture wire 1
Alcohol 3, 4
Candle 1, 4
Ammonium dichromate 4
Crude asbestos 4
Carbon tetrachloride 3, 4
Soft coal
Stick of charcoal 3, 5
No. 30 bare copper wire 1, 4
Dowel rod 7
Soft glass tubing 4
Dry cell 1, 4
Glycerin 3, 4
Iron filings 4
Kerosene
Large nails 1
Manganese dioxide 4
Limewater 3, 4
Magnesium ribbon 4
Mercuric oxide 4
Paste sticks (or splinters of wood) 5, 7
Yellow phosphorus 4
Potassium chlorate 4
Potassium permanganate 3, 4
Potassium nitrate 3, 4
Baking soda 2
Sulphuric acid 4

HEAT

(Note general information page 5)

I. Introduction (page 3)

Core Ideas

Heat plays a very important part in our lives.
Coldness is the absence of heat.
Heat can travel; cold cannot.
To cool anything, one must take heat out of it.
There is some heat in even the coldest things we see or feel.

Possible Approach

Write on the board the questions in the first paragraph of the introduction. Ask the class to read them and try to decide what one would have to know in order to answer them correctly. Then give the class copies of Heat, and let them check their conclusions by reading the first paragraph of the introduction. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activities

1. Find out from reference books what the temperatures are on the other planets in our solar system and on the moon.

2. Find out from reference books about the casting and cooling of the 200-inch mirror for the Mount Palomar telescope.

3. Make a report to the class on the making of artificial diamonds or on some other manufacturing process that makes use of the electric furnace.

Study Problems and Exercises

1. What are the four requirements of our bodies? (*P. 3, ¶ 2*)

2. Mark each of the following sentences "True" or "False."

X (1) The temperatures on all the planets are about the same.
X (2) Cold travels much more easily than heat.
X (3) When you put your hand on a cake of ice, your hand gets cold because cold travels from the ice into your hand.
C (4) To cool anything, you must take heat from it.
X (5) Liquid air is absolutely cold.

II. HEAT, A FORM OF ENERGY (pages 4-5)

Core Ideas

Heat is a form of energy.
Since heat is a form of energy, it can be used to do work.
Heat is only one of several kinds of energy.
There are many sources of heat.
Our most important source of heat is the sun.

Possible Approach

Put on the board before the beginning of the class period two lists. In one list have names of materials; in the other, forms of energy. Heat should be one of the forms of energy listed. Ask the class to make suitable titles for the two lists and to tell what the main differences are between the items in one list and those in the other. Let them check their suggestions by reading the first three paragraphs of the section.

Activities

1. Put a teaspoonful of powdered potassium permanganate in the center of a small sheet of metal. Pour a few drops of glycerin on it. The mixture will become so hot that it will burst into flame. Some of the chemical energy stored up in the chemicals has changed to heat.

2. Rub an eraser vigorously on a piece of paper. Touch it to your lips. Because of the friction between the paper and the eraser, some of the energy of your moving hand is changed to heat.

3. Put a little pile of shavings from a pencil sharpener on a piece of stone or metal. Set them on fire by focusing sunlight on them with a magnifying glass.

4. Connect three dry cells in a circuit with a switch. Connect them in series. Use a short piece of fine copper wire or iron wire to connect two of the cells. Make all the other connections with ordinary electric-bell wire. Close the switch and watch the short

piece of fine wire. Electric energy will be changed to heat energy; and the wire will become hot—probably so hot that it will melt in two.

Study Problems and Exercises

1. There are seven paragraphs in "Heat, a Form of Energy." Give the most important idea of each of these paragraphs in a single sentence.

2. What energy change is there when coal is burned in a furnace? (*P. 5, ¶ 2*)

III. THREE EFFECTS OF HEAT (pages 5-12)

Core Ideas

Heating a material often brings about a rise in temperature.

Heating a material usually causes the material to expand.

Heating a material may bring about a change of state.

Materials, scientists believe, are made of molecules.

The changes brought about by heating a material can easily be explained in terms of molecules.

The effects of cooling a material are the opposite of the effects of heating the material.

The effects of cooling a material can easily be explained in terms of molecules.

Some materials expand more rapidly than others when heated.

Solids that melt, melt at different temperatures.

Materials that boil, boil at different temperatures.

Water expands as it freezes. Ice is therefore lighter than water.

Differences in air pressure bring about differences in the boiling temperature of water.

Water gives off heat as it freezes.

Water vapor gives off heat as it condenses.

Water absorbs heat as it evaporates.

Possible Approach

Fill a beaker with cold water. Let someone in the class feel it. Heat the water for a few minutes with a Bunsen burner, an alcohol lamp, or an electric plate. Let the same person who felt it before feel it again and tell what change has taken place. (*It has become warmer.*) Ask some member of the group to write on the board a sentence which will remind the class of the experiment.

Perform the ball-and-ring experiment. (This experiment is pictured on page 7 and described on pages 6-7 of THERMOMETERS, HEAT, AND COLD, another unitext in this series.) Ask someone to write on the board a sentence telling what the experiment shows.

Put an ice cube in an evaporating dish. Heat the dish until the ice has melted and the water has changed into water vapor and disappeared. Ask someone to write on the board a sentence telling what this experiment shows.

Explain that these three experiments illustrate three of the very common effects of heat. Let the class state as briefly as possible what these three effects of heat are. Then let them check their list by reading the first four paragraphs of the section.

Activities

1. Repeat for yourself the experiment shown in the picture at the top of page 6. The paragraph at the bottom of page 7 explains the experiment. The liquid in the beaker is colored water.
2. Repeat for yourself the experiment shown in the middle and bottom pictures on page 6. The paragraph at the top of page 9 explains the experiment. A Bunsen burner may be used instead of the electric stove. After heating the metal bar has made it curve, plunge the bar into cold water, and watch it straighten.
3. Repeat for yourself the experiment shown in the picture at the top of page 8. The third paragraph on page 10 explains it.
4. Repeat for yourself the experiment shown in the picture on page 34. The second paragraph on page 10 tells you what the experiment is meant to show.
5. Ask the engineer to take the cover off the thermostat in your schoolroom so that you can examine the working part of the thermostat.
6. Take the back off a large watch and look at the balance wheel of the watch.
7. Fill one of the freezing trays of an electric refrigerator level full of water. Put it in the freezing chamber. When the water has frozen, is the tray still level full?
8. Show that ice will float in water.
9. Fill a flask like the one in the top picture on page 6 about one-third full of water. Heat the flask until the water begins to

boil. Then stop heating it. Put a solid rubber stopper firmly in the neck of the flask. Turn the flask upside down so that it rests in a ring fastened to a ring stand like the one shown in the picture on page 8. Pour cold water over the flask. The water inside the flask will begin to boil again. The cold water makes the steam in the flask condense. When the steam condenses, there is much less pressure on the surface of the water in the flask than before, and the water boils at a temperature lower than 212° F. This experiment will help you understand the last paragraph of the section.

10. Find from reference books how carefully our national standard of length is cared for by our government so that its length will not be affected by changes in temperature. Make a report to the class of what you find out.

11. Get a piece of heavy copper or iron wire about three feet long. Stretch it as tightly as possible between two firm supports. The backs of two heavy chairs will do. Hang a small weight from the center of the wire. With a yardstick measure the distance between the bottom of the weight and the floor. Heat the wire along its whole length with a Bunsen burner. Then measure again the distance from the weight to the floor. What change has taken place? (*The wire has expanded so that it is longer than before, and the weight is nearer the floor.*) This experiment will help you understand why telephone wires which sag between the poles in hot summer weather are often stretched tightly between the poles in cold weather.

12. Blow up a toy balloon. Fasten it to the end of a stick. Hold the balloon above a Bunsen burner or an electric stove, being sure that it does not touch the flame or the stove. The balloon will probably expand so much that it bursts.

13. Put a few crystals of iodine in a Pyrex test tube. Heat the lower end of the test tube. The iodine crystals will change to a purple vapor. Some of this vapor will be cooled when it comes in contact with the cool walls of the test tube near the top and will change back again to fine crystals of iodine. The iodine may be driven from one part of the test tube to another by heating first one and then another of the places where the vapor has crystallized.

Study Problems and Exercises

1. The picture on page 4 is one of the illustrations for "Three

Effects of Heat." What connection is there between the picture and the text? (*P. 8, ¶ 3*)

2. What is the cartoon on page 7 meant to show? (*P. 6, ¶ 3*)

3. Match these parts of sentences:

When a gas becomes a liquid, we say that it
When a liquid becomes a solid, we say that it
When a solid changes to a liquid, we say that it
When a solid changes to a gas, we say that it
When an object gets larger when it is heated, we say that it
All materials are believed to be made of
Such changes as those from a solid to a liquid or from a liquid to a gas are called
When a material, as a result of being cooled, takes up less space, we say that it

freezes.
evaporates.
condenses.
molecules.
expands.
changes of state.
contracts.
melts.

4. Head three columns with the names of the three effects of heat you are told about in the first four paragraphs of the section. Then list each of these experiments under each effect of heat it illustrates. (A—*rise in temperature;* B—*expansion;* C—*change of state*)

Page 6, 2nd and 3rd pictures	A, B
Page 6, top picture	A, B
Page 8	C
Page 9	A, B
Page 10	A, B
Page 11	A, B
Page 34	A, B

5. What change brought about in water by a change in temperature is most surprising? (*P. 10, ¶ 4*)

6. Mark each of the following sentences "True" or "False."

X (1) Water always boils at the same temperature.
C (2) Steam is likely to cause a worse burn than boiling water.
C (3) It is very fortunate that water expands with freezing.
X (4) All liquids boil at the same temperature.
C (5) Molecules are always moving.

7. Mark with a *C* all of the following suggestions which you consider sensible. Mark those that are not sensible with an *X*.

X (1) If you are on a mountain, allow only half the time for boiling potatoes that you allow in lower places.

C (2) If you have a cellar in which fruits and vegetables are stored, and if you think that there is some danger that the fruits and vegetables may freeze, put a big tub of water in the cellar near the fruits and vegetables.

X (3) If the glass stopper in a bottle sticks, run very cold water over the neck of the bottle to loosen the stopper.

X (4) If you want water to be much hotter than it is when it begins to boil, boil it for thirty minutes.

C (5) If you want to make the molecules of a material move closer together, cool the material.

8. In one of our science museums there is a large mass of beautiful clear glass standing on a table in one of the halls. Visitors are warned not to touch it for fear the warmth of their hands might break off a piece of glass. How could the warmth of a person's hands break a piece off a large mass of glass? (*The glass that was warmed would expand, while the glass that was not warmed would not. As a result, the glass that was warmed might crack off.*)

IV. MEASURING TEMPERATURE AND HEAT (pages 12-16)

Core Ideas

Temperature is measured with thermometers.

Temperature is measured in degrees.

There are two common thermometer scales—the Fahrenheit scale and the centigrade scale.

There are many different kinds of thermometers.

Some thermometers are better for one purpose, some for another.

Amount of heat is quite different from temperature.

Amount of heat is measured, not in degrees, but in calories or British thermal units.

Possible Approach

Fill a beaker with warm water. Ask someone in the group to find out how warm it is. If he does not ask at once for a thermometer, lead him to do so. Provide him with a chemical thermometer marked with the Fahrenheit scale. When he reads the temperature of the water, raise the question of how the thermometer being used can tell temperature. After the class has worked out an explanation, let them check it by reading the first paragraph of the section.

Activities

1. Examine as many different kinds and shapes of thermometers as you can.

2. Make an air thermometer. You can find out how from page 22 of THERMOMETERS, HEAT, AND COLD.

3. Follow suggestion No. 1 on page 21 of THERMOMETERS, HEAT, AND COLD.

4. Follow suggestion No. 4 on page 21 of THERMOMETERS, HEAT, AND COLD.

5. Examine a broken thermometer. Notice how very tiny the hole in the thermometer tube is. Try to stick a pin into it.

6. Fill a round glass bottle with water. Stand a pencil up in the water. Look at the pencil through the wall of the bottle. Notice how much bigger it looks than it really is. The water in the round bottle acts as a magnifying glass, just as the thick wall of the thermometer tube does.

7. Look at all the thermometers in the science room. Pick out those that could safely be used to take the temperature of boiling water.

8. Fasten a thermometer on a support so that it hangs down into a beaker of boiling water without touching the bottom or sides of the beaker. Read the temperature.

9. Examine a fever thermometer. Take your temperature with it. Then put the bulb of the thermometer in cool water. Does the mercury in the tube go down?

10. Look at the picture on the inside cover of THERMOMETERS, HEAT, AND COLD. Is the thermometer pictured a Fahrenheit thermometer or a centigrade thermometer? (*Fahrenheit*) How do you know?

11. Fill a beaker with warm water. Hang down into it two thermometers, one centigrade and one Fahrenheit. Read the two thermometers and write down your readings. Take your Fahrenheit reading and change it to a centigrade reading by using the formula on page 14 of the unitext. Is your answer the same as the reading of your centigrade thermometer? It should be. If it is not, your arithmetic may be wrong, one or both the thermometers may not be accurate, or you may not have read the thermometers correctly.

12. Pour some mercury into a small glass dish. Then pour it back

into its container. Does any of the mercury stick to the glass dish? Does this experiment help you see one reason why mercury is a satisfactory material for use in thermometers?

13. On page 113 of *From Galileo to Cosmic Rays* there is a graph for use in changing Fahrenheit readings to centigrade readings. Some interesting temperatures are marked on this graph. On a large sheet of graph paper, make a similar graph that can be mounted on the bulletin board.

Study Problems and Exercises

1. Make titles, or captions, for the two pictures on page 14. (Left—*Recording Metal Thermometer;* right—*Air Thermometer*)

2. What is the point to the cartoon on page 15? (*The body temperature of a person that lives in a warm region is the same as the body temperature of a person that lives in a cold region.*)

3. Which one of the foods pictured at the top of page 16 furnishes most heat per pound? Which one furnishes least heat per pound? (*Butter; tomatoes*)

4. "The temperature in the African desert was 120°." What letter should have been put after this temperature reading? How do you know? (*F.—A temperature of 120° C. would be far above boiling temperature.*)

5. Answer each of these questions with either "centigrade" or "Fahrenheit."

(1) What thermometer scale is most used by scientists? (*Centigrade*)
(2) What thermometer scale was invented by Celsius? (*Centigrade*)
(3) On what thermometer scale is the temperature of freezing water 32°? (*Fahrenheit*)
(4) On what thermometer scale is the temperature of boiling water 100°? (*Centigrade*)
(5) On what thermometer scale is —273° the lowest possible temperature? (*Centigrade*)

6. Underline the correct ending for this sentence:

Thermometers measure amount of heat.
temperature.

7. What kind of thermometer (alcohol or mercury) would you advise each of these explorers to take with him?

a) An explorer who wanted to find the temperatures in the regions near the South Pole. (*Alcohol*)

b) An explorer who wanted to study the temperatures high in the stratosphere, where temperatures are very low. (*Alcohol*)

c) An explorer who wished to find the temperature of the water bubbling out of the hot springs in the region he was planning to explore. (*Mercury*)

V. CONDUCTION (pages 16-20)

Core Ideas

Heat may travel through gases, liquids, and solids by conduction.

Some materials are good conductors of heat; some are poor conductors.

Good conductors are used when we wish to make heat travel into or out of anything rapidly.

Poor conductors of heat are used to shut heat either in or out.

Since some materials are very much better conductors of heat than others, we cannot tell temperature accurately by feeling.

Possible Approach

With paraffin fasten marbles at regular intervals on a copper rod or wire a foot or so long. Let someone in the group hold one end of the rod in a flame. He should continue to hold it until all the marbles have dropped off. Let the class try to explain why the marbles dropped off, and why they did not all drop off at the same time. Refer the class to the first paragraph of the section for a name for the way in which heat travels through a copper rod.

Activities

1. Follow suggestion No. 2 on page 36 of the unitext.
2. Follow suggestion No. 4 on page 36 of THERMOMETERS, HEAT, AND COLD.
3. Do the experiment shown in the top picture on page 18. The sixth paragraph on page 17 explains the experiment.
4. Do the experiment shown in the middle picture on page 18. The first two sentences in the fifth paragraph on page 21 explain it.
5. Do the experiment shown in the bottom picture on page 18. The last paragraph on page 17 explains it.
6. Do the experiment shown in the picture on page 28. Do not perform it, however, without some grown person to help you. The

paragraph at the bottom of page 18 describes the experiment.

7. Make a small fireless cooker. You may find out how from the left-hand picture on page 26 and the text on page 29 of THERMOMETERS, HEAT, AND COLD. Crumpled paper or sawdust may be used instead of asbestos, and the soapstone may be left out of a small cooker made just for experiments. After you have made the cooker, test it to see how satisfactory it is. You might, for example, start cooking some oatmeal over a fire and then transfer it to the fireless cooker. Use a thermometer to find out how hot the oatmeal is when you put it into the cooker and again after it has been in the cooker for an hour.

8. Examine a thermos bottle. Perhaps someone in your class has a broken thermos bottle which he can bring for the class to see.

9. Find out which one of two thermos bottles is the better. The thermos bottles should be the same size. Heat some water until it begins to boil. Then fill both thermos bottles with the hot water. Put the corks in the bottles and be sure to screw on the tops carefully. Take the temperature of the water in each bottle twenty-four hours later.

Test the same bottles by using very cold water instead of very hot water. Is the same bottle ahead on both tests?

10. Plan an experiment that will show that some one material is a better conductor of heat than some other material.

11. On a cold day put an iron spoon with a wooden handle out of doors. Leave it there for half an hour or so. When you bring it in, touch the wooden handle with one hand and the iron bowl with the other. Which one feels colder? (*Iron bowl*) If you do not understand why, read again the paragraph at the top of page 20.

12. Light a Bunsen burner. Get a piece of iron-wire screen. Move it horizontally over the top of the Bunsen burner. Be sure that it actually touches the top of the burner. Lift it up. You will find that you can lift up the flame. Give it a flip to one side. The flame will disappear. You have picked up a flame and thrown it away. Of course, you must shut off the gas at once. If you do not understand the experiment, read again the paragraph at the bottom of page 17.

Study Problems and Exercises

1. Name five good conductors of heat.
2. Name five poor conductors of heat.

3. Some of the following objects should be made of materials that are good conductors of heat; some should be made of poor conductors. Write *G* after those that should be made of good conductors and *P* after those that should be made of poor conductors.

radiator (*G*)
stewpan (*G*)
winter coat (*P*)
teacup (*P*)
covering for furnace pipes (*P*)
wall of house (*P*)
pan for freezing ice cubes (*G*)
handle of an electric iron (*P*)
base of an electric iron (*G*)
ice-cream bucket (*P*)

4. Fill the blanks in these sentences:

If you wish heat to travel into or out of anything, you should use a *(good)* conductor of heat.

If you wish to keep heat from traveling into or out of anything, you should use a *(poor)* conductor of heat.

When heat travels by conduction, it travels from *(molecule)* to *(molecule)*.

5. Three of the following statements you cannot explain unless you understand about conduction of heat. Underline each of the three statements.

Fires burn better in pure oxygen than in the air.

On a cold morning you rub your hands together to warm them.

You should not fill a teakettle brimful of water when you are going to put it on a stove to heat.

The part of an ice-cream freezer which holds the cream is made of metal, while the outside container is usually made of wood.

Warm air is lighter than cold air.

A piece of copper which has been lying out in the sun on a hot summer day feels hotter than a piece of wood which is really just as hot.

Iron glows when it becomes very hot.

Woolen clothing keeps you warm.

Telegraph wires which are put up in the summer must not be strung tightly.

6. What would you have to know in order to answer this question correctly? If both were 30° F., which would feel colder to your hand, a large quartz crystal or a mahogany model of a large quartz crystal? (*Whether mahogany or quartz is the better conductor of heat. The better conductor will feel colder.*)

VI. CONVECTION (pages 20-21)

Core Ideas

Heat may travel through gases and liquids by convection.

A convection current is a movement set up in a liquid or a gas by heating it or cooling it.

Convection currents are important in ventilating our houses.

A lake breeze is a convection current.

Possible Approach

Fill a large beaker or deep pan with cold water. Stand it on a support over a Bunsen burner (an electric plate or alcohol lamp may be used instead.) Remind the class that water is a poor conductor of heat. Hang two thermometers down into the beaker. The bulb of one should be within an inch of the bottom of the beaker. The bulb of the other should be within an inch of the surface of the water. Take the temperature of the water. Light the burner. Let the class guess what temperatures the two thermometers will register after the water has been heated for a minute. Then let someone read the thermometers. Do the same thing at the end of five minutes. Let the class try to explain the fact that, although water is a poor conductor of heat, the two thermometers register almost exactly the same temperatures each time. Let them check their suggestions by reading the section.

Activities

1. Do the experiment shown in the top picture on page 22. The last paragraph on page 20 describes the experiment. Notice that the lamp chimney used is resting on little glass dishes that hold it up above the plate of glass on which the candles are standing.

2. Do the experiment shown in the middle picture on page 22. The second paragraph on page 21 describes the experiment. Try leaving only the top holes open. Try any other arrangements of openings that you can think of.

3. Follow suggestion No. 5 on page 36 of THERMOMETERS, HEAT, AND COLD.

4. Draw a diagram showing that you understand what causes a lake breeze.

5. Follow activity No. 4 on page 208 of this manual.

6. Light the candle in a convection box (a metal box with a glass front and with two openings at the top, over which there are lamp

chimneys.) Hold a piece of burning touch paper (paper that produces a great deal of smoke as it burns) over first one chimney and then the other. The smoke will help you see the air currents.

7. Read on page 12 of FIRE, FRIEND AND FOE, another unitext in this series, how a fire makes its own circulation of air.

Study Problems and Exercises

1. A and B were making a fireless cooker. They had a wooden box and a round metal can with a lid. "We'll put the can inside the box and put sawdust between the box and the can," A said.

"We do not need any sawdust," said B. "We must build a wooden rack in the bottom of the box for the can to rest on. Then there will be air all around the can, and we'll be through when we have made a heavy lid for the box."

"Sawdust will be better than air," A insisted.

Which one was right? Why? (*P. 21, ¶ 6*)

2. Mark each of the following sentences "True" or "False."

C (1) There may be convection currents in a gas.
C (2) There may be convection currents in a liquid.
X (3) There may be convection currents in a solid.
C (4) Cold air is heavier than warm air.
C (5) A lake breeze is a convection current.

3. Give some reasonable temperatures for the air indoors and outdoors in the diagram on page 30. (*P. 21, ¶ 1*)

VII. RADIATION (pages 22-24)

Core Ideas

Heat may travel by radiation.

Heat can travel through empty space by radiation.

The heat we get from the sun reaches us by radiation.

The earth radiates heat, too.

Clouds and air act as a blanket and keep the earth from losing its heat rapidly.

Some surfaces absorb radiant heat much better than others.

Surfaces that absorb radiant heat readily will give it off readily.

Possible Approach

Ask the class to read again the third paragraph on page 3. Then raise the question of how heat gets to us from the sun. Can it travel to us by conduction? By convection? Let the class check their suggestions by reading the first paragraph of the section.

Activities

1. Follow suggestion No. 3 on page 36 of the unitext.

2. Repeat for yourself the experiment the boys in the picture on the outside cover are doing. The second paragraph on page 24 explains the experiment.

3. Put a terrarium containing plants that can stand bright sunlight in a sunny window. The terrarium should have a glass cover. Put a thermometer in the terrarium, and another on the shelf beside the terrarium. Read the thermometers at the same time every day for several days. Try to explain any differences you find between the temperatures inside the terrarium and just outside it. The last paragraph on page 23 will help you.

4. Light a candle. Hang a thermometer from some kind of support so that the bulb of the thermometer will be on a level with the candle flame and about half an inch from it. Watch the mercury or alcohol in the tube of the thermometer. What accounts for its rise? (*Heat carried to it by radiation*) Remember that convection currents carry heat upward from the flame, and that air is a very poor conductor of heat.

Study Problems and Exercises

1. Three of the following statements you cannot explain unless you understand about radiation of heat. Underline each of the three statements.

Mercury expands when heated.

The glass walls of a thermos bottle are silvered.

A quart of milk more than fills a quart milk bottle when it freezes.

An explorer who makes a flight into the stratosphere must protect himself from extreme cold, although, if he makes the ascent in the daytime, he is going closer to the sun.

A greenhouse traps heat from the sun.

Iron glows when it becomes very hot.

Fires burn better in pure oxygen than in air.

Warm air is pushed upward by cold air.

2. Why is it very fortunate for us that heat can travel by radiation? (*P. 22, ¶ 1; p. 5, ¶ 3*)

3. The sun is about 93,000,000 miles from the earth. How long

does it take heat to travel from the sun to the earth? (*P. 22, ¶ 2*)

4. A third-grade class got some cecropia moth cocoons. They put a piece of paper on the bottom of a glass aquarium and laid the cocoons on the paper. Then they covered the aquarium with a plate of glass and put it on a sunny window sill. A few days later one of the children lifted the glass cover so that he could feel one of the cocoons. He was very much surprised to find that the air inside the aquarium was much warmer than the air in the room. Explain why it was. (*P. 23, ¶ 5*)

5. On what page in the unitext is there a picture showing one way in which we put to use the principles you used in explaining the problem in No. 4. (*P. 2*)

VIII. HEATING OUR HOMES (pages 24-31)

Core Ideas

There are many things to consider in choosing a heating system for a building.

Different heating systems have different advantages.

Convection currents play an important part in hot-air and hot-water heating systems.

Thermostats can be used to control the temperature of a building.

Possible Approach

Write on the board this sentence: "People have learned how to turn winter into summer." Explain that this is a saying commonly used in accounts of the great strides people have made toward controlling their environment. Ask what it means. (*In winter people can have summer temperatures inside their buildings.*) Then ask the class to name different ways of heating buildings. List the ways on the board. Let the class find by reading whether there are other heating systems not included in their list, how the various systems operate, and what the advantages and disadvantages of each system are.

Activities

1. Ask the engineer of your school building to take you on a tour of the school heating system.

2. Report to the class what kind of heating system heats the building in which you live.

3. Make for the bulletin board a collection of pictures and diagrams of heating systems.

Study Problems and Exercises

1. Make captions for the two diagrams on page 27. (*Stove with a Jacket; Steam Heating System*)

2. "Do you like an oil-burning furnace or a hot-water heating system better?" This is a foolish question. Why? (*P. 31, ¶ 2*)

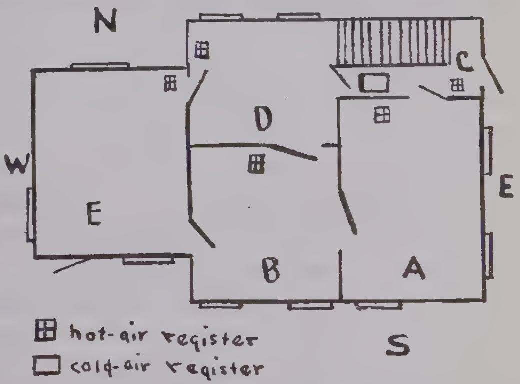
3. What kind of heating system do you have in your home? Name one advantage and one disadvantage of this kind of system.

4. Match these parts of sentences:

In a hot-water system heat is carried to the radiators by	the pressure produced inside the boiler.
In a steam heating system the steam is forced through the radiators by	convection currents.
Coal may be fed gradually into a furnace by	automatic stokers.
The temperature of buildings may be kept even by means of	thermostats.

5. Read carefully the third paragraph on page 20 and the first paragraph on page 28. Draw a diagram showing the two convection currents mentioned. Draw only the furnace room and one room above it.

6. This is the ground-floor plan of a house that is heated by a heating system like the one shown on the inside front cover. The furnace room is under *D*. There are bedrooms above *A*, *B*, *C*, and *D*, but there is an unfinished attic above *E*. The rest of the house is well heated, but *E* is too cold in cold weather. Suggest at least three steps that might be taken to heat *E* without putting any kind of stove in the room itself. The problem is to make hot air come into the room from the furnace, keep cold air from coming



in from outside, and keep the heat brought to the room from escaping by conduction. (*Put a cold-air register in E near the west wall; put a fan inside the jacket of the furnace; put on double windows; put rock wool or some such insulating material between the walls of the room; make the floor double, and put felt or some other poor conductor between the two layers; put on a storm door; put a layer of some poor conductor of heat on the floor of the storeroom above; for a few minutes at a time shut off all the other hot-air registers in the house so that the hot air will be forced up into E.*)

IX. REFRIGERATION (pages 32-34)

Core Ideas

A material can be cooled only by making heat travel out of it.

All refrigeration methods take advantage of the fact that heat is absorbed when a solid melts or evaporates or when a liquid evaporates.

In an ice refrigerator, the ice cools the contents of the refrigerator by melting.

In a mechanical refrigerator a liquid cools the contents of the refrigerator by evaporating.

Possible Approach

Call attention to the heading of the section. Ask why this section belongs in a book about heat. Let the class check their suggestions by reading the first paragraph of the section. Fill a beaker with cold water and ask for suggestions as to how it might be made colder. Try as many as possible of the suggestions offered. Then let the class find from reading how the ways suggested are like the methods used in refrigerators and cooling systems.

Activities

1. Take the temperature of the room with a mercury thermometer like the one in the picture on page 12. Then fan the bulb of the thermometer. Does the mercury go down? This experiment will help you understand that fanning alone does not make things cool.

Now dip the bulb into water that is the same temperature as the air. Hold the thermometer up in the air and fan it. Watch the mercury go down. The bulb is being cooled because the water on it is evaporating.

2. Follow suggestion No. 2 on page 35 of THERMOMETERS, HEAT, AND COLD.

3. Follow suggestion No. 4 on page 36 of the unitext.

4. If you do not object to the smell of ether, try the same experiment with ether.

5. Wet your finger in water of about the same temperature as the air in the room, and hold it up in the air. Blow on it and notice how much cooler it feels. Your breath is making the water evaporate faster than before.

Open your mouth and draw in your breath quickly. Notice how cool your tongue feels. It is cooled by the evaporation of moisture.

6. Examine a small cake of dry ice. Be careful not to touch it with your bare hands. Notice that it does not melt—it changes directly from a solid to a gas. The third paragraph on page 34 of the unitext explains what dry ice is.

7. If you have an electric refrigerator at home, examine it to see where the cooling coils and the motor are.

8. From reference books find out how meats, fruits, and vegetables are now frozen for market. Make a report to the class.

9. Crack a few cubes of ice into small pieces. Put them in a bowl. With a thermometer take the temperature of the melting ice. Make a record of the temperature. Now mix some rock salt with the ice. Take the temperature of the mixture. Try different proportions of rock salt and ice. Rock salt makes ice melt. You may have seen rock salt sprinkled on ice on sidewalks to make the ice melt. As the salt makes the ice in the bowl melt, the melting cools the whole mixture. A mixture of rock salt and ice is often used to freeze ice-cream.

10. Get a petri dish. Turn the cover upside down and put about fifteen drops of water in it. Set the bottom part of the petri dish in the top. Fill the bottom part about half-full of ether. Put the petri dish in front of an electric fan, or fan it with cardboard. The ether will evaporate fast, and the water between the two parts of the petri dish will freeze and hold the two parts of the dish together.

Study Problems and Exercises

1. Mark each of the following sentences "True" or "False."

C (1) Evaporation is a cooling process.

C (2) There are convection currents inside refrigerators.

X (3) Salt water freezes more easily than pure water.

X (4) The walls of a refrigerator are meant to keep cold from traveling through them.

C (5) The walls of a refrigerator are meant to keep heat from traveling through them.

2. In old-fashioned iceboxes the ice rested on the bottom of the box, and the shelves were above the ice. Ice lasted well in these boxes, but food was not kept cold in them nearly so well as in a modern ice refrigerator. What did the position of the ice have to do with this? (*Since the ice was at the bottom of the icebox, the air cooled by the ice stayed where it was, and no convection currents were set up.*)

3. Why is "dry ice" a good name for frozen carbon dioxide? (*P. 34, ¶ 3*)

X. AIR CONDITIONING (pages 34-36)

Core Ideas

Air conditioning includes keeping the air the right temperature, keeping the right amount of water vapor in it, and removing dust from it.

Air conditioning works successfully only in tightly built buildings.

By means of air conditioning, weather indoors can be changed from summer weather to spring weather.

Possible Approach

Call attention to the heading of the section. Let the members of the class tell of any experiences they have had with air conditioning in trains or buildings. Ask what air conditioning includes. Let the class check their ideas by reading the first four paragraphs of the section.

Activities

1. Collect material about air conditioning, and bring it to class to help in making a bulletin board exhibit.

2. Fill a small dish with calcium chloride crystals. Fill a beaker with hot water. Stand them side by side and cover them with a bell jar or a bowl. Let them stand for a day. Some of the water in the beaker will evaporate, and the calcium chloride will absorb it from the air. The calcium chloride may absorb so much that it will dissolve in the water it has taken in from the air. This experiment will help you see that it is possible with chemicals to remove moisture from the air in air conditioning systems.

3. Do the same experiment with table salt instead of calcium chloride. The reason salt often "cakes" in salt shakers is that it takes moisture from the air.

Study Problems and Exercises

1. The building in the picture on page 29 is an air-conditioned building. Notice that the picture was taken on a summer day. Tell three ways in which the air inside the building probably differed from the air outside. (*Cooler, drier, cleaner*)

2. How does air conditioning help people who have hay fever? (*P. 35, ¶ 3*)

3. "Within five years probably most of the houses in our country will be air conditioned." Do you agree with this statement? Quote from the book a statement to back up your idea. (*P. 36, ¶ 1, sentence 1*)

Materials and Equipment

(See page 405)

Different kinds of thermometers, including a clinical thermometer, a centigrade chemical thermometer, a Fahrenheit chemical thermometer, and 2 identical chemical thermometers 4
Broken thermometer
Small glass dish
Petri dish 4
Large beaker 4
Tall, slender, straight-sided graduate or straight-sided chimney 4
Evaporating dish 4
Flask 4
1-holed stopper to fit 4
Solid stopper to fit 4
Test tubes—1 Pyrex 4
Bell jar 4
Soft glass tubing 4
Glass delivery tube 4
Air thermometer tube 4
Black air thermometer tube 4
Terrarium with a glass cover 4
Copper rod or wire 1, 4
Iron picture wire 1, 4
Fine copper wire or iron wire 1, 4
Electric-bell wire 1, 4
Glass funnel 4
Lamp chimney 4
Bunsen burner, alcohol lamp, or electric plate 4
Electric fan 1, 4
Marbles
Conductometer 4
Ball and ring set 4
Compound bar 4
Materials for fireless cooker 4
Iron spoon with wooden handle 1
Tripod and wire gauze 4
Aluminum foil 4
Ventilating box 4
Magnifying glass 4
3 dry cells 1, 4
Switch 1, 4
Ring stand, clamps, and ring 4
Small weight
Toy balloon 6
Convection box 4
Fire, Friend and Foe
Thermometers, Heat, and Cold
From Galileo to Cosmic Rays, by Harvey Brace Lemon
Powdered potassium permanganate 3, 4
Iodine crystals 3, 4
Glycerin 3, 4
Touch paper 4
Calcium chloride crystals 3, 4
Mercury 4
Large sheet of graph paper 5
Alcohol 3, 4
Ether 3, 4
Dry ice
Rock salt 2
Candle 2, 4

LIGHT

(Note general information page 5)

1. Seeing Things (pages 3-5)

Core Ideas

Luminous objects are seen by their own light.

Other objects are seen by reflected light.

We see objects because light from those objects enters our eyes.

Light travels at the rate of about 186,000 miles a second.

Light travels in straight lines.

We can see heavenly bodies that are tremendously far away.

On the earth's surface many things interfere with the traveling of light.

Possible Approach

Give the class copies of Light. Ask the members of the class to look at the outside cover. Then ask why they can see the picture. Have them check any conclusion they reach by reading the first three paragraphs of "Seeing Things." (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activity

Follow suggestion No. 3 on page 21 of the unitext.

Study Problems and Exercises

1. Why can you see the floor of the room you are now in? (*It sends to my eyes some of the light which falls on it.*)

2. Use an idea you are given in the third paragraph on page 3

to divide the following items into two groups. Give each group a suitable title.

a) the sun
b) the moon
c) a mirror
d) a lighted electric lamp
e) a clock
f) the paper you are writing on
g) a bonfire
h) an unlighted candle
i) a lighted candle
j) a goldfish

(Luminous objects: *a, d, g, i;* objects that are not luminous: *b, c, e, f, h, j.*)

3. Give in two sentences two important ideas about how light travels. (*It travels very fast. It travels in straight lines.*)

4. What is the connection between the picture on page 4 and this section of the book? (*P.4, ¶2*)

5. What must happen if you are to see an object? (*P.3, ¶3*)

6. The South Pole is not nearly so far away from you as the moon. Why can't you see the explorations going on near the South Pole? (*P.5, ¶1*)

II. Seeing through Things (page 5)

Core Idea

Some materials are transparent, some are translucent, and some are opaque.

Possible Approach

Call attention to the fact that the class can see through the windows. Ask for an explanation of the fact that they can see through the windows but not through the walls of the room. Check any conclusions they may reach by reading "Seeing through Things."

Activity

Test any ten materials you find in the room to see whether they are transparent, translucent, or opaque.

Study Problems and Exercises

1. What can you tell about cellophane from the picture on page 5? (*It is transparent.*)

2. Use ideas you are given in "Seeing through Things" to divide these materials into three groups. Give each group a suitable title.

a) oiled paper
b) window glass
c) tin foil
d) water
e) brick
f) thin cotton cloth
g) frosted glass
h) tin
i) coal

(Transparent: *b, d;* translucent: *a, f, g;* opaque: *c, e, h, i.*)

III. SHADOWS (pages 6-7)

Core Ideas

Any object that is made of opaque materials casts a shadow when light falls on it from one direction.

The shadow of an object may be very different in size and shape from the object itself.

It is possible to tell the time of day from shadows.

Knowing about shadows helps us understand eclipses.

The air keeps shadows on the earth from being so dark as they would otherwise be.

Possible Approach

Ask some member of the group to stand in a strong light so that he casts a shadow that can be seen easily. Let the class try to explain the shadow. Have them check their explanation by reading the first paragraph of "Shadows."

Activities

1. If the day is clear, measure the length of your shadow at noon today. Measure it again at four o'clock. What makes the difference?

2. Get (or make out of clay) two balls that are not the same size. Darken the room. With a flashlight (or a desk lamp) throw the shadow of the big ball on the little ball. Then throw the shadow of the little ball on the big ball. Which of the two helps you understand an eclipse of the moon? (*First*) Which helps you understand an eclipse of the sun? (*Second*)

Study Problems and Exercises

1. You are told that at the time of an eclipse of the sun, the shadow of the moon on the earth is only a few miles across. Copy the diagram on page 6 which explains why, and put the earth in the diagram.

2. If the moon were larger than the sun, would its shadow on the earth at the time of an eclipse of the sun be larger or smaller than it is now? (*Larger*) Which diagram on page 6 backs up your answer?

3. Shadows on the moon are much blacker than shadows on the earth. Suggest a reason for the difference. (*P. 7, ¶ 1*)

4. Complete these two sentences.

"The sun does not cast a shadow, because it is (*luminous*) ."

"A pane of clear glass does not cast a shadow, because it is *(transparent)*."

5. What does the picture on page 2 have to do with shadows? (*It is a sundial, with which time is told by means of shadows.*)

IV. REFLECTION (pages 7-11)

Core Ideas

Light is regularly reflected from a mirror or any surface that acts as a mirror.

Light reflected from a rough surface is diffused.

The angle at which light strikes a surface is equal to the angle at which it is reflected.

In curved mirrors images of objects may be very different from the images of the same objects in plane mirrors.

Possible Approach

Ask the class to look at the two inside covers of the book. Ask which page shows objects that could not be seen if there were no reflection of light. Read with the class the first two paragraphs of "Reflection."

Activities

1. Follow suggestion No. 1 on page 20 of the unitext.
2. Follow suggestion No. 4 on page 21 of the unitext.
3. Follow suggestion No. 5 on pages 21 and 22 of the unitext.
4. Follow suggestion No. 6 on page 22 of the unitext.
5. Follow suggestion No. 7 on page 22 of the unitext.
6. Follow suggestion No. 8 on page 23 of the unitext.
7. Try holding a mirror in the sunlight and throwing light on a certain spot on the ceiling. Notice the slant at which you must hold the mirror to make the light travel in the direction you wish it to travel. Try to diagram the path of the light.

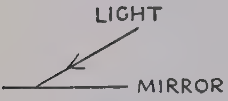
Study Problems and Exercises

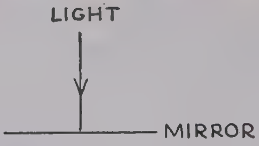
1. Why, in the story in the first paragraph, would the moon be blotted out while the stars kept on shining? (*Moon shines by reflected light.*)

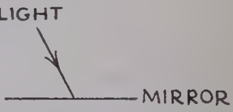
2. What kind of reflection is illustrated by the picture at the top of page 8? (*Regular reflection*)

3. What important idea does the left-hand diagram on page 11 illustrate? (*P. 10, ¶ 3*)

4. Finish the diagrams below by drawing lines to show how the light rays would be reflected from these surfaces.

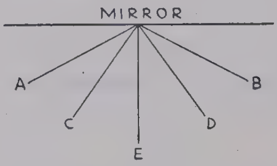






5. Why can't you see yourself in the floor of the room you are in? (*The light which is reflected from it is diffused.*)

6. *A, B, C, D,* and *E,* are people standing near a mirror and looking into it. Tell whose image each one can see.



7. What is the most important difference between the mirror in the right-hand picture on page 10 and the one in the left-hand picture? (*One is curved, the other plane.*)

V. Refraction (pages 11-13)

Core Ideas

Refraction is the bending of rays of light as they pass at a slant from one transparent material to another.

Lenses are applications of the principles of refraction of light.

There are many shapes and sizes of lenses.

Possible Approach

Let the class either singly or in groups follow suggestion No. 9 on page 23 of the unitext. Read with them the explanation given in connection with the directions. Point out that this experiment illustrates refraction of light.

Activities

1. Follow suggestion No. 2 on page 20 of the unitext.

2. Follow suggestion No. 10 on pages 23 and 24 of the unitext.

3. Follow suggestion No. 11 on page 24 of the unitext.

Study Problems and Exercises

1. What do both the pictures on page 12 illustrate? (*Refraction of light*)

2. What is the point to the right-hand picture on page 11? (*P. 11, ¶¶ 3 and 4*)

3. In "See for Yourself," pages 20-24, several experiments have to do with refraction of light. List the numbers of those that do. (*2, 9, 10, 11*)

4. Tell exactly what refraction of light is. (*P. 11, ¶ 4*)

VI. OUR EYES (pages 14-15)

Core Ideas

Our eyes are very complicated.

When we see an object, light from that object enters our eyes and forms images on the retinas at the back of the eyes.

Possible Approach

Ask the class to look at the diagram of the eye on page 14. Point out that it is a cross-section from back to front. Then ask each member of the group to look at the eyes of some other member of the group and find out how many of the parts shown in the diagram can be seen from a front view of the eye. Guide the class in reaching the conclusion that the eye is a very complicated organ that must be well taken care of if it is to continue to function as it should.

Activities

1. Follow suggestion No. 12 on page 24 of the unitext.

2. Follow suggestion No. 3 on page 35 of the unitext.

3. Your school may have a model of an eye which can be taken apart and examined. If so, examine it and compare it with the diagram on page 14.

Study Problems and Exercises

1. List all the parts of the eye that are labeled in the diagram on page 14. Tell what purpose each of these parts serves.

2. In what way is the lens of the eye better than a glass lens? (*Curvature can be changed.*)

3. What is an optical illusion? (*P. 15, ¶ 1*)

VII. Helps for Seeing (pages 15-18)

Core Ideas

Among our helps for seeing are microscopes, telescopes, eyeglasses, periscopes, field glasses, and opera glasses.

These helps for seeing contain lenses, mirrors, or prisms, or combinations of two or more of these devices.

Possible Approach

Show the class a slide on which something is mounted which is too small to be seen without a microscope. (It may be, for example, blood corpuscles, pollen grains, bacteria, yeast plants, or mold spores.) Ask the class how it is possible to see such tiny objects. If a compound microscope is available, show how to arrange the microscope and the slide, and let the children look at the slide through the microscope. If a compound microscope is not available, call the attention of the class to the picture of a microscope on page 15. Raise the question of what there is in the microscope which makes it magnify. Have them check any suggestions they may make by reading the first five paragraphs of "Helps for Seeing."

Activities

1. Look through as many as you can of the instruments mentioned in this section.

2. Make a periscope according to the directions given on pages 19-20.

Study Problems and Exercises

1. If you wished to examine a disease germ, which one of the instruments mentioned in this section would you use? (*Microscope*) If you wished to see the great nebula pictured on page 4? (*Telescope*) If you wanted to look out of a window above your head to see what was happening outside? (*Periscope*)

2. Name three other instruments which are helps in seeing. Underline those that contain lenses.

X. Color (pages 24-27)

Core Ideas

Sunlight is made up of the colors of the rainbow.

White objects reflect light of all colors.

Black is the absence of color.

The color of an opaque material depends on what color of light it reflects.

The color of a transparent material depends on what color it allows to pass through it.

Since lamplight differs somewhat from sunlight so far as the colors in it are concerned, things do not look exactly the same color by lamplight as by sunlight.

Possible Approach

With a prism (a mounted one, if possible) throw a band of rainbow colors on the wall. Discuss the source of the band of colors. Let the class pick out from the band all the individual colors they can distinguish. Have them check their ideas by reading the first paragraph of "Color."

Activities

1. Follow suggestion No. 1 on page 35 of the unitext.
2. Follow suggestion No. 2 on page 35 of the unitext.
3. Follow suggestion No. 4 on page 36 of the unitext.
4. Experiment with a color wheel if you can.
5. Examine an anaglyph if you can.
6. Perhaps the school has a color top which works just as a big color wheel does. Experiment with making designs in color and rotating them with the color top.

Study Problems and Exercises

1. Complete the following sentences:

"Sunlight is a combination of these colors: *(violet)*, *(indigo)*, *(blue)*, *(green)*, *(yellow)*, *(orange)*, and *(red)*."

"By means of a *prism* sunlight can be broken up into a band of colors."

2. Why does a red dress look red? (*P. 26, ¶ 3*) In the light of a mercury vapor lamp there are no red rays. What color would a red dress look in the light of such a lamp? (*Black*)

3. Explain what the difference between black and white is. (*P. 26, ¶ 1*)

4. What does "complementary color" mean? What is the complementary color of blue? (*See suggestion No. 4 on page 36 of the unitext.*)

5. Of what use is a color wheel like the one shown on page 26? (*To show that white light is made up of the rainbow colors.*)

XI. Taking Pictures (pages 28-30)

Core Ideas

Light may bring about chemical changes.

Some chemicals are sensitive to light.

Light-sensitive chemicals make taking pictures possible.

A camera is very much like the human eye.

Possible Approach

Call attention to the title of this section. Then call attention to the pictures at the top of page 28. Ask for explanations of the change in color. Ask, too, what the fading of cloth has to do with taking pictures. Have the class check any ideas they express by reading the first two paragraphs of "Taking Pictures."

Activities

1. Follow suggestion No. 5 on page 36 of the unitext.
2. Look through a pinhole camera.

Study Problems and Exercises

1. List again the parts of the eye that are labeled in the diagram on page 14. Head this list "Human Eye." In a second list headed "Camera," tell what, if anything, in a camera corresponds to each part of the eye in your list.

2. What kinds of chemicals make the taking of pictures possible? (*P. 28, ¶ 2*)

3. How does the image of any object in a pinhole camera differ from the object itself? (*P. 28, ¶ 4*)

4. A moving-picture film is made up of a series of pictures. If you looked at these pictures singly with a magnifying glass, you would see no movement. Why do you see movement when the film is run through a moving-picture projector? (*P. 30, ¶ 3*) What one of the experiments in "See for Yourself," pages 35-36, helps you understand moving pictures? (*No. 3*)

XII. Light as a Messenger (pages 31-34)

Core Ideas

Light is used as a messenger in many ways.

Light would be a more efficient messenger if there were not so many things on the earth's surface to interfere with it.

Possible Approach

Call attention to the title of the section. Ask for any experiences the members of the class have had which would make them think of light as a messenger. Refer the class to the unitext for further ways in which messages can be sent by means of light.

Activities

1. Candles can be used instead of torches in sending messages a short distance. Use the code on page 31 to send messages a short distance.

2. If there are any Boy Scouts in your group, perhaps they will show the class how to send a message by wigwagging.

Study Problems and Exercises

1. List five ways of signaling in which light is the messenger.

2. Why isn't light used more often than it is for long-distance messages? (*P. 34, ¶ 1*)

XIII. Lighting Our Streets and Buildings (page 34)

Core Ideas

Many ways of artificial lighting have been devised.

Earlier artificial lamps depended for their light on the burning of some fuel.

In electric lamps no burning takes place.

New ways of lighting are being experimented with.

Possible Approach

Darken the room. Light a candle. Let some member of the group find out how near the candle he must hold a book in order to get light enough to read the book. Discuss other methods of lighting and compare them with the candle.

Activity

Plan and set up an exhibit of new and old lighting devices.

Study Problems and Exercises

1. Tell an important difference between a common electric-lamp bulb and a gas lamp. (*P. 34, ¶ 4*)

2. Make a suitable title for the sketches on page 22. (*Lighting devices*)

Summary Exercises

1. Mark each of the following sentences "True" or "False."

X (1) Eyesight goes out from our eyes to objects which we see.

C (2) We see objects when light from those objects enters our eyes.
C (3) White light is a mixture of colors.
C (4) Light rays are bent when they pass at a slant from air into water.
X (5) White is an absence of color.
C (6) A yellow object reflects yellow light.
X (7) Luminous objects reflect light to our eyes.
C (8) Darkness is merely an absence of light.
X (9) A blue object reflects all colors of light.
X (10) Objects in water are always where they appear to be.
C (11) Light travels faster than sound.
C (12) The earth casts a shadow.
C (13) The moon casts a shadow.
X (14) The sun casts a shadow.
X (15) A common magnifying glass contains a concave lens.
C (16) The eye contains a lens.
C (17) Light changes certain chemicals.
X (18) When light is reflected by a mirror, it always goes back along the path by which it reached the mirror.
C (19) Light can be used to send messages.
C (20) Light from the sun may be separated into colors of the spectrum by means of a prism.

2. Underline the correct endings for the following sentences:

1) Light from the moon
   a) is given off by the moon itself.
   b) *is reflected sunlight.*
   c) is light reflected from distant stars.
2) The thunder caused by a flash of lightning is
   a) heard at the same time the lightning is seen.
   b) heard before the lightning is seen.
   c) *heard after the lightning is seen.*
3) The bending of rays of light as they pass through a convex lens is called
   a) reflection.
   b) diffusion.
   c) *refraction.*

4) To a person on the bank of a stream, a fish in the middle of the stream looks to be
    a) exactly where it is.
    b) *higher than it is.*
    c) lower than it is.
5) A blue dress
    a) reflects light of all colors.
    b) absorbs blue light and reflects other colors.
    c) *reflects blue light and absorbs other colors.*
6) The black letters on this page
    a) *absorb most of the light that falls on them.*
    b) reflect all the light that falls on them.
    c) reflect most of the light that falls on them.
7) When there is a rainbow in the afternoon, it is always
    a) *in the east.*
    b) in the west.
    c) in the north.
8) In a camera an image is formed on the plate or film by
    a) a concave mirror.
    b) a prism.
    c) *a convex lens.*

Materials and Equipment

(See page 405)

Prism 4
Color wheel 4
Color top 4
Pinhole camera 4
Compound microscope 4
Model of eye 4
Lenses of different curvatures 4
Curved mirrors of different curvatures 4
2 square mirrors without frames 4
Flashlight
Microscope slides 4
Piece of red glass or cellophane
Plate of glass ⅛ in. thick
Thin plate of glass
Small metal pan 1
Anaglyph 8
Candles 2, 4
Materials for periscope (p. 19)
Blueprint paper 4
Cards

MATTER AND MOLECULES

(Note general information page 5)

I. INTRODUCTION (page 3)

Core Ideas

All materials take up space and have weight.

All materials together are spoken of as matter.

Possible Approach

Arrange an assortment of materials somewhat like the one pictured on page 2 of the unitext. Ask the class to count the different materials in the assortment. Have them back up their count by listing the materials. Discuss each material listed from the standpoint of the characteristics that made it possible for the class to identify it. Then raise the question of whether there are any ways in which all the materials are alike. Let the group check their suggestions by reading the first three paragraphs on page 3. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activities

1. Select several objects made of different materials and show by using a balance that they all have weight. List the objects in order according to weight.

2. Select several objects made of different materials and show that they take up space by sinking them in water and watching the water level change. List the objects in order according to the space they take up.

3. Check to see how the order in the two lists compares. What conclusion can you draw? (*The weight of an object depends on the material of which it is made as well as on its size.*)

Study Problems and Exercises

1. In what two ways are all the things pictured on page 2 alike? (*They all have weight; they all occupy space.*)

2. Here is a list of familiar words. Put a line under each material named in the list.

electricity
butter
heat
water
sugar
air
sound
sand
space

3. What one word can be used for all materials? (*P. 3, ¶ 6*)

4. On three pages in the book there are pictures which illustrate the last sentence in paragraph 4 on page 3. On what pages are these illustrations? (*Pp. 6, 11, and 14.*)

II. SOLIDS, LIQUIDS, AND GASES (pages 4-6)

Core Ideas

A material may be a solid, a liquid, or a gas.
A solid has a definite shape and size.
Solids may occur in the form of crystals.
A liquid has a definite size but no shape of its own.
Surface tension is a characteristic of liquids.
A gas has no shape or size of its own.

Possible Approach

Use the same assortment of materials used in the initial approach. Ask the class to suggest as many different ways as they can of dividing the materials into groups. Then call attention to the heading of this section. Raise the question of whether it suggests a different grouping or one already mentioned.

Activities

1. Collect materials and group them into three groups on the basis of whether they are solids, liquids, or gases.

2. Follow suggestion No. 2 on page 36 of the unitext.

3. Try the experiment shown on page 5. Be sure to drop in the paper clips one at a time. Be careful not to jar the tumbler.

4. Demonstrate surface tension by floating a paper clip on the surface of water.

5. Examine some mercury. Dip a piece of paper into the mercury. Does the paper get wet? Spill a little mercury on a

table. How does it behave differently from water? Find out as many of its properties as you can. Do not let mercury touch any gold. If you do, particles of mercury will go in between the particles of gold and will make the gold look like silver.

6. Try the two experiments pictured on page 6.

7. Plan an experiment of your own to show that air takes up space.

8. Find as many devices as possible which make use of the principle that air takes up space. (*Popgun, football, bicycle tire, etc.*)

9. Examine particles of sand, sugar, and flour through a microscope to see the shape of the particles.

Study Problems and Exercises

1. Write two accurate statements describing each of the following: solids (*P. 4, ¶¶ 2-3*), liquids (*P. 4, ¶¶ 6-7*), gases (*P. 6, ¶¶ 1 and 3*)

2. Here is a list of familiar items. Head three columns "Solids," "Liquids," and "Gases," and list each item in the appropriate column.

sand (*S*)
wood (*S*)
ice (*S*)
air (*G*)
iron (*S*)
clay (*S*)
water (*L*)
syrup (*L*)
rayon cloth (*S*)
water vapor (*G*)
hydrogen (*G*)
gasoline (*L*)
mercury (*L*)
oxygen (*G*)

3. Mark these sentences true or false:

C (1) Solids keep their shape.
X (2) All solids are hard.
C (3) Iron is a solid.
X (4) Liquids keep their shape.
C (5) Liquids take the shape of the container they are in.
X (6) Liquids spread out to completely fill any container they are in.
C (7) Water is a liquid.
X (8) Gases keep their shape.
C (9) Some gases are colored.

III. CHANGES OF STATE (pages 7-8)

Core Ideas

Changes of gases to liquids or solids, of solids to liquids or gases, and of liquids to gases or solids are called changes of state.

Evaporation is the changing of a liquid or solid to a gas.

Boiling is a form of evaporation in which bubbles of vapor are formed below the surface of a liquid.

Melting is the changing of a solid to a liquid.

Freezing is the changing of a gas or a liquid to a solid.

Condensation is the changing of a gas to a liquid or a solid.

In any change of state a transfer of heat takes place.

Changes of state are of great practical importance.

Possible Approach

Put some ice cubes in a glass funnel resting in a funnel support. Put a beaker under the funnel so that the water from the melting ice will drip into it. Ask the class to tell what is happening. (*The ice is melting.*) Ask them then to use the words "solid" and "liquid" to tell what is happening. (*A solid is changing to a liquid.*) Wash a small part of the blackboard with a wet cloth. As the water disappears, ask what is happening. (*The water is evaporating.*) Suggest then that they use the words "liquid" and "gas" to tell what is happening. Let them find out by reading the first two paragraphs of the section what name scientists give to all changes similar to those they have been watching.

Activities

1. Follow suggestion No. 3 on page 36 of the unitext.
2. Follow suggestion No. 4 on page 36 of the unitext.
3. Follow suggestion No. 5 on page 36 of the unitext.
4. Follow suggestion No. 6 on page 36 of the unitext.
5. Change water from one state to another by changing temperature. Do this in several ways.
6. Show by allowing alcohol to evaporate from the bulb of a thermometer that evaporation is a cooling process.
7. Change crystals of iodine to iodine vapor as shown in the left-hand picture on page 8.

Study Problems and Exercises

1. Explain what we mean by changes of state. (*P. 7, ¶ 1*)

2. Using forms of water, illustrate each of the following changes of state:

1) Solid to liquid
   (*Ice to water*)
2) Liquid to gas
   (*Water to water vapor*)
3) Liquid to solid
   (*Water to ice*)
4) Gas to liquid
   (*Water vapor to water*)
5) Solid to gas
   (*Ice to water vapor*)
6) Gas to solid
   (*Water vapor to ice*)

3. Copy the list in Exercise 2 and after each change listed give a single scientific term for it.

1) (*Melting*)
2) (*Evaporation*)
3) (*Freezing*)
4) (*Condensation*)
5) (*Evaporation*)
6) (*Condensation, or freezing*)

4. What two changes of state are illustrated in the diagram on page 7? (*Evaporation, or boiling; condensation.*)

5. What accompanies every change of state? (*P. 8, ¶ 4*)

6. What change of state is taking place in the left-hand picture on page 8? (*Evaporation—a solid is changing to a gas.*)

7. What change of state was the right-hand picture on page 8 put in to illustrate? (*Melting—changing from a solid to a liquid.*)

IV. Puzzles To Explain (pages 9-11)

Core Ideas

Change of state was for a long time a puzzling problem.

Dissolving, diffusion, and expansion and contraction constituted other puzzling problems.

Possible Approach

Remind the class of the experiments they have thus far carried out in the unit. Ask whether those experiments are still puzzling in any way. Let them check their suggestions with the questions listed in the first paragraph of the section.

Activities

1. Perform for yourself the ball-and-ring experiment shown on page 10.

2. Examine some crystals of salt with a microscope. Notice

that they are tiny cubes. Dissolve some salt in water. Examine a drop of the solution with a microscope. Can you see any particles of salt?

3. Mix some cornstarch and water. Filter the mixture. If any of the cornstarch is dissolved, it will go through the filter paper with the water that goes through. Put a drop of iodine in the liquid that has gone through the filter paper. If any cornstarch has gone through, a purple color will result. What do you conclude? (*Cornstarch does not dissolve in water.*)

4. Mix some baking soda and water. Filter the mixture. If any of the baking soda has dissolved, it will go through the filter paper along with the water. Put a few drops of vinegar in the liquid that goes through the filter paper. If bubbles appear, they will be bubbles of carbon dioxide and will show that there is baking soda in the water. What will you then know about baking soda? (*It dissolves in water.*)

5. Find a way of showing that water expands when heated. If you need help, see the unitext THERMOMETERS, HEAT, AND COLD.

6. Find a material that has these properties: It is a solid. It is transparent. It is hard. It can be molded easily. It melts at a very high temperature. It is brittle. It will not dissolve in water or any other common solvent. Chemical changes in it are difficult to bring about; for this reason it is much used for laboratory containers and for some types of laboratory apparatus.

7. Try dissolving crystals of different sorts—sugar, copper sulphate, etc.—in water.

8. Melt a tablespoonful of sugar in a spoon over a flame. Dissolve another tablespoonful in a small amount of water. Notice that melting and dissolving are quite different.

9. Make alum crystals, following the directions given in suggestion No. 6 on page 36 of the unitext STORIES READ FROM THE ROCKS.

10. Follow suggestion No. 7 on page 36 of the unitext.

11. Follow suggestion No. 8 on page 36 of the unitext.

12. Follow suggestion No. 9 on page 36 of the unitext.

13. Follow suggestion No. 10 on page 36 of the unitext.

14. Try for yourself the experiment pictured in the left-hand picture on page 9.

Possible Approach

1. List the four major "puzzles" mentioned on pages 9, 10, and 11. (*P. 9, ¶ 1; p. 10, ¶ 4; p. 10, ¶ 7; p. 11, ¶ 3.*)

2. In what way is melting different from dissolving? (*P. 9, ¶ 3*)

3. Mark the following statements true or false:

C (1) A solution is clear.
X (2) The particles in it can be seen with a microscope.
C (3) In a solution the particles stay all through the liquid.
X (4) Starch will dissolve in water.
C (5) More materials will dissolve in water than in any other liquid.
X (6) Carbon dioxide gas will not dissolve in water.
X (7) All materials will dissolve in water.
X (8) Solutions are never colored.

4. Tell in one word what change each of these pictures illustrates:

P. 9, left-hand picture	(*Diffusion*)
P. 9, right-hand picture	(*Dissolving*)
P. 10	(*Expansion*)
P. 11	(*Expansion*)

V. Molecules (pages 12-14)

Core Ideas

The molecular theory explains change of state, expansion and contraction, dissolving, and diffusion.

According to the molecular theory all materials are made up of very tiny particles, or molecules, which are constantly in motion.

Materials are held together by the attraction of their molecules for one another, this attraction being greatest in solids and least in gases.

Molecules, although constantly in motion, are not alive; living things, however, are made of molecules.

Molecules differ in size.

Possible Approach

Call attention to the heading of the section. Ask various members of the group what the word "molecule" means to them. Let the class check the ideas presented by reading page 12.

Activity

Use small bits of clay to illustrate molecules. Arrange them to illustrate solids, then liquids, and then gases.

Study Problems and Exercises

1. What is the molecular theory? (*P. 12, ¶ 1*)

2. In the following three boxes illustrate the molecular theory by drawing in molecules. (*Diagrams on p. 12.*)

Solid Liquid Gas

3. Mark these statements true or false:

C (1) There is greater attraction between molecules of solids than between molecules of liquids.

C (2) Spaces between molecules of liquids are smaller than those between molecules of gases.

C (3) Molecules of all kinds of matter are believed to be moving.

C (4) Molecules are moving in still air.

C (5) Molecules are moving in iron.

C (6) Molecules are so tiny that they can pass through the small holes in filter paper.

C (7) Scientists believe that all kinds of matter are made of particles called molecules.

C (8) Molecules are too small to be seen by the naked eye.

4. Show by drawing a block of wood and a few of the molecules in it why a block of wood keeps its shape. The diagram at the bottom of page 13 will help you somewhat.

5. Draw a "before-and-after" diagram to show in terms of molecules what happens to the brass ball in the experiment pictured on page 10.

6. Draw a diagram to show what in terms of molecules is happening in the flask on page 7.

7. Draw a diagram to show what happens in terms of molecules when a lump of sugar is dissolved in water. Use different colors to stand for sugar molecules and water molecules.

8. What happens to a grain of sugar when it goes into solution? (*P. 13, ¶ 7*)

9. Draw diagrams to show in terms of molecules what happens in the experiment shown in the left-hand picture on page 9.

VI. Physical Changes (pages 15-16)

Core Ideas

Many of the changes that go on about us are physical changes.

In physical changes the molecules continue to be the same as in the beginning; no new materials are produced.

In contrast, in chemical changes the molecules are changed and new materials are produced.

Possible Approach

Give various members of the group slips of paper on each of which there are directions for bringing about some simple physical or chemical change. After the directions have been followed, ask the class to divide the changes brought about into two groups on some logical basis. After they have arrived at grouping them into changes in which a new material is formed and changes in which there is no new material, ask them to find from the text names for the two groups of changes. (*Physical changes and chemical changes.*)

Activities

1. Use water and sugar to illustrate a physical change.

2. Show by using small balls of clay to stand for molecules some physical change. Let the class identify it.

3. Perform the experiment pictured in the right-hand illustration on page 15. It is described on page 16.

4. Perform the experiment pictured in the left-hand illustration on page 15. The materials used are a solution of mercuric chloride and a solution of sodium hydroxide.

5. Perform the experiments pictured on pages 10, 26, 27, and 28 in the unitext WHAT THINGS ARE MADE OF.

6. Plan a demonstration of your own that will illustrate physical change.

Study Problems

Here is a list of changes. Classify them into two groups on the basis of the main idea of this section.

Iron expanding (*Physical change*)
Paper burning (*Chemical change*)
Sugar melting (*P*)
Bubbles of CO_2 being given off from vinegar and soda (*C*)
Water freezing (*P*)
Water evaporating (*P*)
Iron rusting (*C*)
Wood decaying (*C*)
Sugar being dissolved in water (*P*)
Paper being torn into bits (*P*)

VII. THE BEGINNINGS OF CHEMISTRY (pages 17-18)

Core Ideas

Greek philosophers were interested in chemical changes but did no experimenting to find out whether their ideas were right.

The alchemy of the Middle Ages was the forerunner of modern chemistry.

Possible Approach

Call attention to the pictures on pages 16 and 17. Ask for any suggestions as to why these pictures should have been put in a part of the book that deals with chemistry. Let the class check the suggestions offered by reading the first three paragraphs of the section.

Activities

1. Read in other books more about the work of Aristotle.
2. Follow suggestion No. 11 on page 36 of the unitext.

Study Problems and Exercises

1. Justify this statement: "Chemistry began with the Greeks." (*P. 17, ¶ 4*)

2. Justify this statement by telling three contributions alchemists made: "Alchemy was the forerunner of modern chemistry." (*P. 18, ¶ 3*)

VIII. ELEMENTS, COMPOUNDS, MIXTURES (pages 19-25)

Core Ideas

A material may be an element, a compound, or a mixture.

The elements are the simple substances out of which all other materials are made.

Elements may be gases, liquids, or solids.

Every element has been given a symbol by chemists.

In a compound, two or more elements are joined together to form a material quite different from any of the elements in it.

Mixtures may be mixtures of elements, mixtures of compounds, or mixtures of elements and compounds.

Mixtures and compounds may be gases, liquids, or solids.

Possible Approach

Show an assortment of various elements without calling them "elements" and lead the class to identify each one. Explain then that, in one way of grouping materials, all of these materials belong in the same group. Let them find out from page 19 what group it is.

Activities

1. Read in current magazines about the new elements found.
2. Follow suggestion No. 12 on page 36 of the unitext.
3. Follow suggestion No. 13 on page 36 of the unitext.
4. Follow suggestion No. 14 on page 36 of the unitext.
5. Do the experiments pictured on pages 14, 16, 18, 21, and 25 of WHAT THINGS ARE MADE OF.

Study Problems and Exercises

1. Write the chemical symbols for each of the following:
    Three elements pictured on page 19 (*S, C, I*)
    Two elements which are liquids (*Hg, Br*)

Three elements which are gases (*O, H, N*)
One liquid element which is a metal (*Hg*)

2. Divide the items in this list into elements, mixtures, and compounds.

ginger ale (*M*)
milk (*M*)
water (*C*)
air (*M*)
mercury (*E*)
copper (*E*)
red lead (*C*)
bronze (*M*)
enamel (*M*)
salt (*C*)
manganese dioxide (*C*)
iron (*E*)
nickel nitrate (*C*)
hydrogen (*E*)
brass (*M*)
steel (*M*)

3. Write the symbol for each of the following elements.

Neon (*Ne*)
Nickel (*Ni*)
Phosphorus (*P*)
Platinum (*Pt*)
Silicon (*Si*)
Silver (*Ag*)
Sodium (*Na*)
Tin (*Sn*)
Tungsten (*W*)
Zinc (*Zn*)
Aluminum (*Al*)
Argon (*A*)
Calcium (*Ca*)
Chlorine (*Cl*)
Chromium (*Cr*)
Copper (*Cu*)
Gold (*Au*)
Helium (*He*)
Iron (*Fe*)
Lead (*Pb*)

4. If you were to take apart the following compounds, you would find ten different elements. Make a list of them.

iron oxide
sodium chloride
copper sulphate
calcium carbonate
potassium chlorate
water

(*Iron, sodium, oxygen, chlorine, copper, sulphur, calcium, carbon, potassium, and hydrogen*)

IX. Atoms (pages 22-25)

Core Ideas

The atomic theory was worked out to explain how chemical changes come about.

According to the atomic theory, molecules are made of atoms, the smallest particles of elements.

The formula of a compound tells the kinds of atoms in it and the proportion in which the atoms are combined.

In chemical changes atoms are regrouped.

Possible Approach

Call attention to the heading of the section. Ask various members of the group to tell what the word "atoms" means to them. Let the class check the ideas presented by reading the first three paragraphs of the section.

Activities

1. Use small balls of colored clay to illustrate the difference between a mixture and a compound.

2. Find chemical formulas fo ras many as possible of the cooking materials which your mother has on her pantry shelves —sugar, salt, starch, vinegar, etc.

3. Illustrate by using colored clay the building up and breaking down of a compound.

Study Problems and Exercises

1. What is the atomic theory? (*P. 22, ¶ 2*)

2. Of what elements are each of the following compounds made?

Water (H_2O) (*Hydrogen, oxygen*)
Salt (NaCl) (*Sodium, chlorine*)
Sugar ($C_{12}H_{22}O_{11}$) (*Carbon, hydrogen, oxygen*)
Hydrochloric acid (HCl) (*Hydrogen, chlorine*)
Carbon dioxide (CO_2) (*Carbon, oxygen*)
Carbonic acid (H_2CO_3) (*Hydrogen, carbon, oxygen*)
Sodium hydroxide (NaOH) (*Sodium, oxygen, hydrogen*)

3. On each line below name an element, a compound containing the element, and a mixture containing either the element or a compound of it. (*Examples:*

Oxygen	*Water*	*Air*
Sodium	*Salt*	*Ocean water*)

4. Describe each of the following compounds by telling the kinds and numbers of atoms in a molecule:

Carbon dioxide (*1 carbon and 2 oxygen*)
Starch (*6 carbon, 10 hydrogen, and 5 oxygen*)
Marble (*1 calcium, 1 carbon, and 3 oxygen*)

5. Here is a chemist's story of a chemical change. Tell in words what happened. $C_{12}H_{22}O_{11} \rightarrow 12C + 11H_2O$
(*Sugar broke up into carbon and water.*)

6. Tell what happened here: $Mg + O \rightarrow MgO$
(*Magnesium joined oxygen to form magnesium oxide.*)

7. In each of the following groups put an *X* in front of the one item which is different from the other three, and in the space below tell how the other three are alike.

Example:

_____ sand and water
__X__ nitrogen
_____ starch and water
_____ iron and sulphur ground together
(The others are mixtures.)

a) _____ phosphorus
__X__ baking soda
_____ chlorine
_____ gold
(The others are elements.)

b) _____ mercuric oxide
__X__ mercury
_____ carbon dioxide
_____ water
(The others are compounds.)

c) __X__ soil
_____ dry ice
_____ iron sulphide
_____ citric acid
(The others are compounds.)

d) _____ NaOH (sodium hydroxide)
__X__ Si (silicon)
_____ CH_3COOH (vinegar)
_____ H_2SO_4 (sulphuric acid)
(The others are compounds.)

e) _____ NaCl
_____ CO_2
__X__ Au
_____ $FeSO_4$
(The others are compounds.)

f) __X__ water
_____ iron
_____ calcium
_____ carbon
(The others are elements.)

g) __X__ CO
_____ Co
_____ Cl
_____ Cu
(The others are elements.)

h) __X__ Hg
_____ H_2O
_____ HCl
_____ H_2SO_4
(The others are compounds.)

X. EIGHT COMMON ELEMENTS (pages 25-30)

Core Ideas

Among the common elements are hydrogen, oxygen, carbon, aluminum, iron, sulphur, silicon, and nitrogen.

Some of these elements occur in nature only in compounds.

All living material contains carbon, oxygen, hydrogen, and nitrogen.

All acids contain hydrogen.

All bases contain hydrogen and oxygen.

Some elements are metals.

Possible Approach

Explain that the pictures on page 25 are meant to suggest the eight elements with which the section deals. Let the class try to tell what element is suggested by each picture and why that picture suggests the element. Let them hunt in the text for backing for their ideas.

Activities

1. Generate several bottles of oxygen in the way described on page 27. Find from WHAT THINGS ARE MADE OF some experiments you can try with it.
2. Generate oxygen from red oxide of mercury. See page 12 of WHAT THINGS ARE MADE OF.
3. From FIRE, FRIEND AND FOE, another unitext in this series, find out more about the role oxygen plays in fire.
4. Look at the pictures on page 32 of THE EARTH A GREAT STOREHOUSE, another unitext in this series, of ores in which some of our common metals occur.
5. Test tapioca, flour, rice, and potatoes for starch.
6. Test lemons, onions, and apples for sugar.
7. Show with litmus paper that tomatoes, lemons, and apples contain acids. Test other fruits in the same way.
8. Find out whether ammonia water is an acid, a base, or neither. Be careful not to hold your nose over the bottle of ammonia.
9. Find out more about sulphuric acid, one of the commonest acids.

10. Find out from page 36 of THE EARTH A GREAT STOREHOUSE how to use hydrochloric acid in testing rocks.

11. Find out how many different kinds of acids there are in your science room. Write down the formulas for all of them. What do the formulas show about all these acids?

12. Make hydrogen as described on page 28 but collect only a test tube full. Using a test tube holder bring the mouth of the test tube close to a flame. Listen for the sound of the slight explosion that occurs. Be careful not to get a flame near the generating bottle.

13. Find out from SOIL, another unitext in this series, how bacteria take nitrogen from the air and build it into compounds other plants can use.

Study Problems and Exercises

1. Match the following by drawing lines from each statement or phrase in the first column to a word in the second column.

All living material is made partly of it
A very light metal
Most common of all elements
Necessary for burning
Lightest of all substances
Industry depends on it
A yellow powder
Diamonds are one form of it
A part of glass
More than four-fifths of the air

iron
silicon
sulphur
carbon
aluminum
oxygen
nitrogen
hydrogen

2. Materials need oxygen in order to burn. Materials will burn in air that contains oxygen. Water is made of hydrogen and oxygen, but materials will not burn in water. Explain. *(P.27,¶2)*

3. Check the correct answer or answers:

a) It would be foolish to try to get oxygen from
___ potassium chlorate
___ mercuric oxide
_X_ iron sulphide
_X_ nitrogen

b) When a drop of iodine is added to cooked rice, the rice turns purple. This shows that

X rice contains starch.
___ rice contains sugar.
___ rice contains an acid.
___ rice contains a base.

c) When Fehling's solution is added to lemon juice, an orange color appears. This shows that

X lemon juice contains sugar.
___ lemon juice contains an acid.
___ lemon juice contains water.
___ lemon juice is sour.

4. Copy in a column the names of the eight common elements named in the first paragraph of the section. After the name of each element tell one way in which it is important.

XI. Controlling Chemical Changes (pages 31-35)

Core Ideas

Chemical changes can be brought about in various ways.

Knowing how chemical changes are brought about helps us control them.

Electric currents, heat, light, and mixing materials bring about many chemical changes.

Certain chemicals—catalysts—bring about changes in other chemicals without being changed themselves.

Bacteria, yeasts, and molds bring about chemical changes in foods not protected from them.

Possible Approach

Lead the class to recall all the different ways in which, in experiments previously carried on in the unit, they have brought about chemical changes. Then ask them to look at the pictures on pages 30 to 35 to see whether the pictures suggest further ways of bringing about chemical changes. Ask them also to find through a quick glance at the text any other ways mentioned in which chemical changes are brought about.

Activities

1. Break water up into hydrogen and oxygen as shown on page 30.

2. Try the experiment with glycerin and potassium permanganate shown on page 31. Be sure to put the potassium permanganate on a piece of metal.

3. Place a few pieces of soft coal in a pyrex test tube. Fit the test tube with a one-hole rubber stopper which has a short piece of glass tubing in it. Arrange as on page 32. Heat the test tube. When gases begin to come from the short piece of glass tubing set them on fire. Notice the coal tar which forms inside the test tube. When the test tube is cool again examine the coke that has formed. Repeat the experiment using wood instead of coal. Charcoal is formed instead of coke.

4. Perform the experiment shown in the left-hand picture on page 31.

5. Perform the experiment described on page 32 and pictured on page 33.

6. Mix equal parts of baking soda and powdered citric acid. Notice that no change takes place. Then add water. A chemical change starts at once and bubbles of carbon dioxide are given off.

7. Follow suggestion No. 15 on page 36 of the unitext.

8. Follow suggestion No. 16 on page 36 of the unitext.

9. Follow suggestion No. 17 on page 36 of the unitext.

10. Place samples of cotton materials in sunlight to see whether or not you can bring about chemical changes.

11. Fill a tall bottle almost full of a solution of baking soda. Color the solution any color you please with colored ink or with vegetable coloring. Put three or four mothballs in the bottle. Then add several crystals of citric acid. The mothballs are only a little heavier than the solution. The bubbles of carbon dioxide that form on them lift them to the surface. Then some of the bubbles escape and the balls sink again. If you have the right amounts of baking soda and citric acid, the balls will travel up and down for quite a long time.

Study Problems and Exercises

1. List five ways in which chemical changes are brought about. *(P. 31, ¶¶ 2 and 4; p. 32, ¶¶ 3 and 7; p. 33, ¶ 1)*

2. Why do we not wish to stop all chemical changes? *(P. 35, ¶ 2)*

3. Name one chemical change which must go on if we are to live. (*P. 33, ¶ 1*)

4. What would you use to bring about the following chemical changes?

Changing mercuric oxide into mercury and oxygen (*Heat.*)
Making iron sulphide from iron and sulphur (*Heat.*)
The chemical change shown on page 30 (*Electricity.*)
Taking a picture with a camera (*Light.*)
The chemical change shown on page 31 (*Mixing two materials.*)
The chemical change shown on page 33 (*Adding water to the mixture.*)
The chemical change shown on page 27 (*Mixing two materials.*)
Making a pattern on blueprint paper (*Light.*)
The fading of clothes (*Light.*)
Copper-plating (*Electricity.*)

5. What would you do to prevent the following changes?

The breaking up of potassium chlorate into oxygen and potassium chloride.	(*Keep it cool.*)
The souring of milk.	(*Check the growth of bacteria.*)
The breaking up of baking powder into carbon dioxide and other materials.	(*Keep it dry.*)
A fire like the one pictured on page 31.	(*Keep potassium permanganate and glycerin apart.*)

Materials and Equipment

(See page 405)

Glass tumbler
Florence flask, pyrex, and 1-holed stopper to fit 4
Thistle tube 4
Aquarium, or any large glass container for water 4
Glass funnel 4
Beaker, pyrex 4
Glass tube 4
Footed test tubes 4
Plain test tubes 4
Pyrex test tube, and 1-holed stopper to fit 4
Short glass tube with end drawn out to small opening 4

Blueprint paper 4
Colored cotton fabric scraps
Dry ice
Muddy, salty water
Sand
Ice cubes
Sugar 2
Flour 2
Salt 2
Cornstarch 2
Baking soda 2
Vinegar 2
Baking powder 2
Erlenmeyer flask, pyrex, and 4 2-holed stopper to fit 4

Delivery tube 4
Glass straw 4
Pipette 4
Balance 4
Microscope 4
Bunsen burner or alcohol lamp 4
Distilling apparatus 4
Mercury thermometer 4
Test tube holder 4
Ball-and-ring set 4
Tripod 4
Funnel support 4
Tongs 4
Ring stand and clamp 4
Magnet 4
Electrolysis apparatus 4
Dry cells 1, 4
Copper wire 1, 4
Rubber tube 4
Modeling clay 5
Filter paper 3, 4
Paste sticks 5
Paper clips 8
Needle
Notebook ring 5
Pan 1
Toy volcano with pan "crater"
Toy boat, or any suitable substitute
Flat cork 4
The Earth A Great Storehouse
Fire, Friend and Foe
The Scientist and His Tools
Soil
Stories Read From the Rocks
Thermometers, Heat and Cold
What Things Are Made Of
Foods to test for sugar and starch 2
Yeast cake 2
Grape juice 2
Ink, or vegetable coloring 5, 8, 2
Mothballs 3
Marble chips 4
Soft coal
Strip of copper 1, 4
Mossy zinc 4
Magnesium ribbon 4
Mercury 4
Phosphorus 4
Powdered iron 4
Powdered sulphur 3, 4
Assortment of elements
Ether 3, 4
Alcohol 3, 4
Carbon tetrachloride 3, 4
Glycerin 3, 4
Iodine crystals 3, 4
Iodine solution 3, 4
Copper sulphate crystals 3, 4
Powdered alum 3, 4
Camphor gum 3, 4
Potassium permanganate 3, 4
Mercuric chloride 4
Sodium hydroxide solution 4
Silver nitrate 3, 4
Sulphuric acid 3, 4
Ammonium dichromate 4
Red oxide of mercury 4
Potassium chlorate 4
Manganese dioxide 4
Hydrochloric acid 3, 4
Ammonia water 2, 3, 4
Powdered citric acid 3, 4
Citric acid crystals 3, 4
Litmus cubes 4
Limewater 3, 4
Fehling's solution 4
Red and blue litmus paper 3, 4

OUR OCEAN OF AIR

(Note general information page 5)

I. Introduction (page 3)

Core Ideas

We live at the bottom of an ocean of air at least 100 miles deep.

Our ocean of air, or atmosphere, is a part of the earth.

Without our atmosphere, life of the kinds we know would be impossible on the earth.

Possible Approach

Give the class copies of Our Ocean of Air. Call attention to the title of the book. Draw on the board a circle about a foot in diameter to stand for the earth. Draw a circle six inches greater in diameter around the first circle to represent the top of the ocean of air. Ask the class to criticize the diagram. (*The ocean of air is not nearly so deep in proportion to the diameter of the earth.*) Remind the class that the earth is really about 8,000 miles in diameter, and let them find by reading the first paragraph of the section whether any criticism of proportion they may have made is sound. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Study Problems and Exercises

1. What causes the sky on a clear day to look blue? (*P. 3, ¶ 2*)

2. You probably know that the earth is one of the sun's family of nine planets. Many people are interested in knowing whether people could live on the other planets. The fourth paragraph on page 3 suggests one question that they must be able to answer about a planet before they can tell whether people could live there. What is it? (*Does it have an atmosphere like ours?*)

II. AIR A REAL MATERIAL (pages 3-6)

Core Ideas

Air takes up space.

Air can be compressed.

A vacuum is an empty space.

Most so-called "empty" containers are really filled with air.

The air near the surface of the earth is denser than at higher altitudes.

Possible Approach

Put a long-necked funnel through a one-holed rubber stopper which fits tightly into the neck of a flask. Put the stopper in the neck of the flask. Let some member of the class try to fill the flask with water by pouring it through the funnel. Let the class try to explain why the water does not run smoothly down into the flask. Have the class check their explanation by reading the first paragraph on page 4.

Activities

1. On pages 10, 11, 12, and 13 of THE AIR ABOUT US, another unitext in this series, there are several very simple experiments which show that air is a real material. Perform any of those experiments which you have not previously performed.

2. Get a piece of glass tubing with a very fine hole, or bore. The exact length is of no importance. Plug up one end in some way. A little modeling clay will serve the purpose. Then try to fill the tube with water colored with red ink. You will find that the air in the tube keeps the water out.

Study Problems and Exercises

1. Why does the picture on page 5 belong in a book about the air? (*P. 4, ¶ 4*)

2. People usually use the word "empty" to mean what? (*Containing nothing but air.*)

3. What is compressed air? (*P. 5, ¶ 1*)

4. Draw a diagram to show that you understand the second paragraph on page 5. You might draw a straight line to represent a small part of the earth's surface and use dots to represent particles of air.

5. What is a vacuum? (*P. 5, ¶ 3*)

III. WIND (pages 6-9)

Core Ideas

Wind is moving air.

Wind varies in velocity.

Winds are named from the direction from which they come.

Winds have brought about many changes in the earth's surface.

Instruments for showing the direction and velocity of the wind have been invented.

Possible Approach

Call the attention of the class to the pictures on pages 8 and 9. Let them try to tell what these pictures have to do with the air. Let them check their ideas by reading the first paragraph of "Wind" and the paragraph at the bottom of page 8.

Activities

1. For a week keep a record of wind direction. Make your record at the same time each day.
2. Make a weather vane. There are directions for a very simple weather vane on pages 29 and 30 of THE AIR ABOUT US, another unitext in this series.
3. With a small electric fan and a sand pan full of sand try to show how wind can pile up hills of sand.

Study Problems and Exercises

1. Of what use is the instrument in the picture at the top of page 20? (*P.6, ¶4*)
2. From what direction is the wind coming in the sketch at the bottom of page 7? (*NW*)
3. Tell any six of the ways in which aviators can tell the direction of the wind. (*P.7, ¶4; p.8, ¶1*)
4. Of what use is a wind tunnel? (*P.8, ¶2*)

IV. FLOATING AND FLYING (pages 9-11)

Core Ideas

Lighter-than-air craft float in the air.

Heavier-than-air craft are held up in the air by differences in the pressure of the air on their upper and lower surfaces.

Possible Approach

Ask the class to find photographs in the unitext of three types of aircraft. Let them try to tell the differences between them. Have them check their answers by reading the section.

Activities

1. Plan a way of showing that hot air is lighter than cold air. (*If you will put a straight-sided lamp chimney around a lighted candle and push a strip of cardboard which is just the width of the lamp chimney down into it part way, you will find that the cold air falls down one side of the piece of cardboard and pushes the hotter, lighter air up the other side.*)

2. Look in encyclopedias and books about travel by air for pictures of early balloons. Show to the class any such pictures you find.

Study Problems and Exercises

1. Different kinds of aircraft are spoken of as "lighter-than-air craft" and "heavier-than-air craft." Which float and which fly? (*Lighter-than-air craft float; heavier-than-air craft fly.*)

2. How can a balloonist control the height to which his balloon rises or sinks? (*P. 10, ¶ 1*)

3. Draw a diagram showing what keeps an airplane in the air. (*It should be very much like the kite diagram at the bottom of page 11.*)

V. STREAMLINES (pages 11-12)

Core Ideas

Air offers resistance to any object moving through it.

Streamlining is meant to reduce the resistance offered by the air.

Possible Approach

Ask the class to explain why the train pictured on page 12 should be called a "streamliner." What is the point of streamlining a train? Let them check their suggestions by reading the first three paragraphs of "Streamlines."

Activities

1. Make a collection of pictures of streamlined automobiles, trains, and airplanes. If you can get a fairly large collection of pictures, you will see that not all engineers agree as to the best plans for streamlining.

2. Plan a way of showing that air offers resistance. (*The way a piece of paper held horizontally and then dropped falls to the ground is one of many simple ways of showing that air offers resistance.*)

Study Problems and Exercises

1. Fill the blanks in this sentence:

"If the air did not ___*(offer)*___ ___*(resistance)*___, trains, planes, and automobiles would not need to be streamlined."

2. Name one instance in which the resistance the air offers is a help. (*Keeps a person making a parachute jump from falling fast.*)

3. Why should the picture on page 31 be included in a book about air? (*P. 11, ¶ 3*)

VI. AIR PRESSURE; VII. MEASURING AIR PRESSURE (pages 13-23)

Core Ideas

The air exerts great pressure.

Air pressure is exerted in all directions.

Understanding about air pressure helps one understand many common phenomena.

Air pressure varies with the weather.

Weather forecasters, in order to be able to predict the weather accurately, must have accurate records of air pressure.

Air pressure varies with altitude.

Barometers are instruments for measuring air pressure.

There are various types of barometers.

Possible Approach

Perform the experiment shown in the left-hand picture on page 15.

Activities

1. Follow suggestion No. 2 on page 36 of the unitext.

2. Follow suggestion No. 1 on pages 35 and 36 of the unitext.

3. In "Fun with Air Pressure," beginning on page 18 of the unitext THE AIR ABOUT US, there are several very simple experiments with air pressure. Perform any which you have not performed before.

4. Put a balloon over the neck of a flask (or bottle). Set the flask on the platform of an air pump. Cover the flask with a bell jar and pump some of the air out of the bell jar. As the air pressure on the outside of the flask and balloon is reduced, the air inside the balloon pushes out and makes the balloon swell up. Let

the air into the bell jar again. The balloon goes back to its original size.

5. Put an aneroid barometer like the one shown in the right-hand picture on page 19 on the platform of an air pump. Cover it with a bell jar. Pump out a little of the air in the bell jar and watch the hand of the barometer move. Let the air into the bell jar again and watch the hand move in the other direction.

Study Problems and Exercises

1. Find out how much the air in your schoolroom weighs. (P. *13*, ¶ *2*)

2. What pushed the balloon in the pictures on page 14 into the flask? (*P. 16, ¶ 1*)

3. If you took along a tank of air strapped to your back, would it be safe for you to visit the moon if you could? Why or why not? (*P. 14, top of page*)

4. What does the little sketch on page 16 have to do with air pressure? (*P. 16, ¶ 2*)

5. Of what use is a barometer? (*P. 19, ¶ 1*) The pictures in this book show three kinds of barometers. What are they? (*Mercury, aneroid, recording*)

6. You would not buy a barometer unless you were interested in one of two things. What are they? (*P. 19, ¶ 2*)

7. If you hoped the day would be fine so that you could go on a picnic, what would you want the barometer to show? (*P. 19, ¶ 4*)

8. Why did von Guericke's water barometer have to be so much taller than the mercury barometers shown on page 20? (*P. 22, ¶ 1*)

VIII. PUTTING AIR TO WORK (pages 23-28)

Core Ideas

Men long ago learned how to harness the force of the wind to work for them.

Many devices are operated by air pressure.

Compressed air is useful for such purposes as driving pneumatic tools and making it possible for workmen to work under water.

Possible Approach

Call the attention of the class to the diagram on the inside back cover. Let the class try to explain it. Then have them check by reading the explanation of tunnel-building which begins near the top of page 27.

Activities

1. Follow suggestion No. 6 on page 36 of the unitext.

2. If the school has a glass pump like the one shown in the right-hand picture on page 15, use it to pump water from one bowl into another.

3. In the *Saturday Evening Post* for March 14, 1936, there was an article called "—but They Build Tunnels." It tells of the experiences of a new "sand hog" in a caisson. You may be interested in reading it.

Study Problems and Exercises

1. Name five different devices for using air pressure. (*P. 25, ¶ 1*)

2. Why must the cylinder of a lift pump never be more than 34 feet above the surface of the water in a well? (*P. 24, ¶ 3*)

3. If you had a rubber tube long enough and had a way of getting it in place, could you siphon water over the top of the building you are in? Why or why not? (*P. 25, ¶ 3*)

4. Why should the picture on page 33 be included in a book about the air? (*P. 28, ¶ 1*)

IX. The Gases of the Air (pages 28-32)

Core Ideas

Air is a mixture of several gases.

The composition of the air remains fairly constant.

A continual trading of oxygen and carbon dioxide is going on between green plants and animals.

The air is made up largely of oxygen and nitrogen.

The amount of water vapor in the air varies.

Winds help keep the composition of the air fairly uniform over the earth.

Possible Approach

Put on the board a pie diagram like the one at the bottom of page 27, but with no key. Tell the class that the pie represents the air, and let them tell what each section represents. Have them check their suggestions by looking at the diagram on page 27.

Activities

1. Follow suggestion No. 3 on page 36 of the unitext.

2. Follow suggestion No. 4 on page 36 of the unitext.

Study Problems and Exercises

1. Suppose you have two bottles. You know that one is full of oxygen and the other of nitrogen. How could you tell which was which? (*P. 30, ¶ 3*)

2. Mark each of the following sentences "True" or "False."

C (1) Our bodies need oxygen.
C (2) We get oxygen from the air.
C (3) Our bodies need nitrogen.
X (4) We get the nitrogen we need from the air.
C (5) Green plants use up carbon dioxide.

X. Liquid Air (pages 32-33)

Core Ideas

Air can be changed to a liquid.

The chief reason for making liquid air is that nitrogen and oxygen can be separated from liquid air easily.

Possible Approach

Call the attention of the class to the little sketch at the top of page 32. Let the class find, by reading the first four paragraphs of "Liquid Air," what this sketch has to do with the air.

Study Problems and Exercises

1. What is liquid air? (*P. 32, ¶ 1*)
2. Why is liquid air manufactured? (*P. 33, ¶ 1*)

XI. High in the Sky (pages 33-35)

Core Ideas

The layer of air immediately above the earth's surface is called the "troposphere."

Above the troposphere is the stratosphere.

Conditions in the stratosphere are very different from conditions in the troposphere.

Possible Approach

Read to the class an account of one of the balloon flights into the stratosphere. For example, one of the following:

Piccard, Auguste. "Ballooning in the Stratosphere," *National Geographic Magazine,* March, 1933.

Stevens, Capt. Albert W. "Exploring the Stratosphere," *National Geographic Magazine,* October, 1934.

Stevens, Capt. Albert W. "Man's Farthest Aloft," *National Geographic Magazine,* January, 1936.

Study Problems and Exercises

1. Why are expeditions into the stratosphere made in airtight gondolas instead of open baskets? (*P. 34, ¶ 3*)

2. What would be the advantages for an airplane of flying in the stratosphere? What would be the disadvantages? (*P. 34, ¶ 5*)

Materials and Equipment

(See page 405)

Long-necked funnel 4
Flask 4
1-holed rubber stopper to fit flask 4
2-holed rubber stopper to fit flask 4
Piece of glass tubing with a very small bore 4
Small electric fan 1
Straight-sided lamp chimney 1, 4
Vacuum pump 4
Bladder glass 4
Thin sheet of rubber 4
Deep pan 1
Magdeburg hemispheres 4
Tumbler
Wide-mouthed bottle 4
Barometer tube 4
Small bowl
Pipette 4, 3
Quart milk bottle
Piece of rubber tubing 4, 3
Small pan or saucer
Test tube 4
1-holed stopper to fit test tube 4
Plate of glass
Suction dart 6
Aneroid barometer 4
Glass lift pump 4
Thistle tube 4
Bunsen burner 4
Glass U-shaped tube 4
Glass lemonade straw
Materials for weather vane
Modeling clay 5
Toy balloons 6
Mercury 4
Candle 1, 2, 4
Hydrochloric acid 3, 4
Marble chips 4
Potassium chlorate 4
Manganese dioxide 4

THE SCIENCE OF BUILDING

(Note general information page 5)

I. INTRODUCTION (pages 3-4)

Core Ideas

Builders have throughout the ages had much the same problems to solve.

The chief problems are those of choosing materials, building a firm foundation, deciding on the type of construction, and planning the building to fit its surroundings.

Possible Approach

Raise with the class the question of what science problems there are in connection with building. Check by examining the titles of the various sections of THE SCIENCE OF BUILDING. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activities

1. Follow suggestion No. 1 on page 36 of the unitext.
2. Find and mount pictures of structures which you would consider wonders of the modern world.

Study Problems and Exercises

1. Identify each of the following: *(See list on pp. 3 and 4.)*

A Greek temple at Ephesus remarkable for its stone pillars.

A hundred-foot bronze statue which guarded the harbor of Rhodes.

A mammoth tomb built by King Khufu of Egypt.

A forty-foot seated figure covered with sheets of ivory and gold.

A beautiful stone tomb more than one hundred feet high.

A five-hundred foot stone tower on top of which fires were kept burning to warn sailors of rocks.

A series of towering walls of stone with roads and gardens on top.

2. Check each of these sentences which correctly describes the Great Pyramid.

✓ It was the first of the Seven Wonders to be built.
✓ It is the only one of the Seven Wonders still standing.
__ It was made entirely of sandstone.
✓ It was equipped with ventilating shafts.
__ It took a great deal of complicated machinery to build this structure.
✓ It was the work of hundreds of thousands of slaves.

3. Why is the building of a huge structure less of a problem for people today than it was for the people of ancient times? *(P. 4, ¶ 5)*

4. List four problems which the builders of long ago had to solve. Underline those in your list which the builders of today must solve. *(P. 4, ¶ 5)*

II. BUILDING MATERIALS (pages 5-14)

Core Ideas

Man has used a great many different building materials, each with different characteristics.

Durability, resistance to fire, cost, manageability, strength, and appearance are among the characteristics to be considered in choosing a building material.

Possible Approach

Show the class an assortment of pictures of buildings, bridges, and other structures showing as wide a variety of building materials as possible. Ask what generalization about building materials can be made from the pictures. Check by reading the first paragraph of the section.

Activities

1. Follow suggestion No. 2 on page 36 of the unitext.
2. Follow suggestion No. 3 on page 36 of the unitext.

3. Follow suggestion No. 4 on page 36 of the unitext.

4. Follow suggestion No. 5 on page 36 of the unitext.

5. Arrange an exhibit of building materials of various kinds.

6. Learn to identify various kinds of building stone.

7. Read in the unitext STORIES READ FROM THE ROCKS about how the rocks now used as building stone were formed.

8. Test various rocks with hydrochloric acid to determine whether the rock has lime in it. If it has, it is either limestone, marble, or artificial limestone (concrete).

9. Visit a lumber yard or store which handles building materials and ask to see the substitutes for wood they have for sale.

10. Demonstrate the fact that asbestos is fire resistant.

11. Find out how, in your locality, different building materials compare in price.

Study Problems and Exercises

1. Copy the list of building materials, named in the first paragraph on page 5. Underline those which you have seen used as building materials.

2. From the standpoint of building materials how does the situation in our country differ from that in New Guinea, Central Asia, and the Far North? (*We have a much wider choice.*)

3. Identify each of the following building materials:

1) It is gray and dull in appearance, but is inexpensive and fire-resisting. It can be used only in dry climates. (*Adobe*)
2) It is limestone which has been changed by underground heat and pressure into a hard rock. It can be highly polished. (*Marble*)
3) It is a natural rock sometimes used for shingles. It is very durable and fireproof, but is heavy and expensive. (*Slate*)
4) It is made of clay which is heated in a kiln to a temperature of 1800° F. (*Brick*)
5) It is a mixture of cement, sand, and gravel or crushed rock which, when hardened, is really an artificial limestone. (*Concrete*)

4. Mark these sentences true or false:

C (1) Asbestos is a good material for shingles.
X (2) Reinforced concrete is concrete with aluminum rods imbedded in it.
C (3) Plaster used on the outside of a building is called stucco.
X (4) Acids attack granite more than limestone.
C (5) Mortar made of sand, cement, and water is used to hold bricks in place.
C (6) Plasterboard is made of gypsum mixed with fibers.
X (7) Vermiculite is the best kind of tile for kitchens and bathrooms.
X (8) Steel is used in the construction of skyscrapers because it does not rust.
C (9) Adobe is sun-dried brick.
X (10) Sandstone is the hardest and most durable of all building materials.

III. Firm Foundations (pages 15-16)

Core Ideas

The permanency of a building depends partly on the firmness of its foundations.

Bedrock, which underlies the earth's surface everywhere, furnishes a solid base on which foundations can be made to rest.

Compressed air can be used in helping to sink foundations to bedrock.

Possible Approach

Remind the class that the Great Pyramid, the oldest of the Seven Wonders, is the only one still standing. Ask what they learned about the foundation of the pyramid which they think may help account for the fact that it is still standing. Check by reading the first paragraph of the section.

Activities

1. Follow suggestion No. 6 on page 36 of the unitext.
2. Follow suggestion No. 7 on page 36 of the unitext.

3. Arrange a pile of large pebbles on a layer of sand. Arrange another on a flat slab of rock. Pour water over the pebbles on both foundations and note what happens.

4. If any large buildings are being built in your neighborhood, find out all you can about their foundations.

Study Problems and Exercises

1. Upon what is the foundation of skyscrapers and giant bridges laid? (*Bedrock*)

2. Give one reason why the Great Pyramid is still standing. (*It was built on bedrock.*)

3. One of the very large buildings in Chicago is built on a so-called floating foundation instead of on a foundation extending to bedrock. Check the statement which you think most likely to be the right explanation.

_____ There is no bedrock under Chicago.
__√__ The bedrock is a considerable distance below the surface.
_____ A floating foundation is more solid than one extending to bedrock.

4. What device is often used to enable men to sink foundations to bedrock? (*A caisson*)

5. This paragraph describes how a caisson works. Fill in the blank spaces.

The caisson, which consists of a great tube of (*steel*) or (*concrete*), is stood above the place in the (*bedrock*) where the foundation pier is to rest. As (*sand*) and (*soil*) are removed from within and underneath the lower edges of the caisson, the (*caisson*) sinks. Then new sections are added to the (*top*). When water is reached, the lower part of the caisson is made into a (*floorless*), (*airtight*) working chamber. (*Compressed*) air is forced into this chamber to keep (*water*) out. Air does not escape from the chamber when men enter or leave because (*airlocks*) are used. (*Airlocks*) serve, too, to enable the workmen to become accustomed gradually to the change in air pressure as they enter or leave the working chamber. After the caisson has been sunk, it is filled with (*concrete*) to form a solid (*foundation pier*).

IV. Types of Construction (pages 17-25)

Core Ideas

In construction the chief problems center about roofing or bridging an open space.

Distribution of weight is one of the problems that must be considered carefully.

Dome, post and lintel, arch, truss, and steel-girder construction are types of construction much used in buildings.

Among the common types of construction used in bridges are suspension, cantilever, steel arch, truss, continuous span, post and lintel, and bascule.

Possible Approach

Show the class a picture or a model of the Leaning Tower of Pisa. Discuss the problem of why the tower does not fall down. Check by reading the first paragraph of the section. Make sure that the class understands the term "center of gravity."

Activities

1. With wooden building blocks show the plan described in the first paragraph of making a wall stable.
2. Follow suggestion No. 8 on page 36 of the unitext.
3. Follow suggestion No. 9 on page 36 of the unitext.
4. Follow suggestion No. 10 on page 36 of the unitext.
5. Collect and mount pictures of buildings to illustrate different types of construction.
6. With a building set make a miniature bridge.
7. Experiment with levers so that you will understand the heavy weights at the ends of a bascule bridge. MACHINES, another unitext, will help you.
8. Build an igloo out of clay blocks.

Study Problems and Exercises

1. What is the chief problem in building a tower that will not tumble over, assuming that good materials and a firm foundation have already been provided? (*P. 17, ¶ 1*)
2. Tell one good way of solving this problem. (*P. 17, ¶ 1*)
3. Where in the book do you find a picture of a house in which the roof and the walls are all one? (*Inside front cover*)

4. In what kind of building are the blocks of the building material laid in a spiral so that each block leans against one placed just before it? (*An Eskimo igloo*)

5. Tell two ways in which the domed building on page 17 is different from an igloo. (*P. 18, ¶ 1*)

6. Tell two ways in which the domed building on page 17 is like an igloo. (*P. 18, ¶ 1*)

7. List five types of construction used in rectangular buildings. (*Post and lintel, corbeled arch, true masonry arch, trusses, and riveted steel framework.*)

8. Identify each of the following types of construction:

An arch in which each stone projects a little beyond the one below it.	(*Corbeled arch*)
A type of construction in which the walls do not have to withstand the outward thrust of the roof and the weight of the upper stories.	(*Steel framework*)
A framework made up of triangles.	(*Trusses*)
The simplest type of construction used in rectangular buildings.	(*Post and lintel*)
The arches shown on the outside cover.	(*True masonry arch*)

9. Draw a small sketch to show that you understand what a flying buttress is.

10. Fill in the following statistics about the Empire State Building:

How far below ground level does the foundation extend? (*33 ft.*)
How high above street level does it extend? (*1,250 ft.*)
How many stories high is it? (*102*)
How many tons of steel were used in the framework? (*57,000*)
Of what are the outer walls of the first 85 stories made? (*Indiana limestone*)
How much limestone was used? (*200,000 cu. ft.*)
How much aluminum? (*450 tons*)
How much stainless steel? (*300 tons*)
How many bricks? (*10,000,000*)

What is the total weight resting on the concrete foundation blocks? (*600,000,000 lbs.*)
How many miles of elevator shafts? (*7*)
How many miles of electric wire? (*About 48,000*)
How many industries were involved in building it? (*1,500*)

11. Identify the type of bridge construction in each of the following:

Each span is supported by more than two piers.	(*Continuous span*)
The roadway is suspended from a steel arch which rests on piers extending to bedrock.	(*Steel arch*)
The roadway is supported from great steel cables attached to piers extending to bedrock.	(*Suspension*)
A stationary bridge built on the principle of the lever. .	(*Cantilever*)
A movable bridge built on the principle of the lever.	(*Bascule*)
A bridge in which a truss above the floor distributes the weight of any load moving over the bridge.	(*Simple truss*)

12. What type of bridge is the San Francisco-Oakland Bridge. (*P. 23, ¶ 3*)

V. Guarding Against Special Stresses and Strains

(pages 26-28)

Core Ideas

Expansion and contraction caused by changes in temperature present problems to builders.

Wind and sound may set structures to vibrating, with perhaps serious results.

In some regions earthquakes present especially serious problems to builders.

Ways have been worked out of taking care of all these stresses and strains.

Possible Approach

Call attention to the section heading. Ask the class to suggest what some of the special stresses and strains might be. Let them check their list by a brief survey of the section.

Activities

1. Follow suggestion No. 12 on page 36 of the unitext.
2. Observe the sidewalks near the school to see what precaution, if any, has been taken against cracking and buckling from heat and cold.
3. Find and read additional material about earthquakes.
4. From the unitext SOUND find a way of showing that sound is produced by vibrations.

Study Problems and Exercises

1. What accounts for the fact that the Golden Gate Bridge may on a cold day be up to 20 ft. higher than on a hot day? (*P. 26, ¶ 1*)
2. Why is one end of the bridge pictured on page 27 placed on rollers? (*P. 26, ¶ 2*)
3. In what two ways has the Golden Gate Bridge been made flutter-proof? (*Heavy suspended span, and strong, flexible supports.*)
4. Why do some people get seasick on top of the Eiffel Tower? (*Because the tower sways so in the wind.*)
5. How can a pipe organ wreck an entire building? (*Sound vibrations can set buildings to fluttering.*)
6. List five plans for helping make buildings earthquake-proof. (*See p. 28*)

VI. BUILDING TO FIT MOISTURE CONDITIONS

(pages 29-30)

Core Ideas

Roofs are designed differently to fit different conditions of rainfall.

Foundations are designed differently to fit different moisture conditions.

Building materials are chosen with moisture conditions in view.

Possible Approach

Call attention to the picture on the inside back cover and to the one on page 29. Ask the class to account for the major difference, aside from that of the materials used, between the two types of buildings. Check by reading the first two paragraphs of the section.

Activities

1. Find pictures of buildings made to withstand much rain and snow and of buildings designed for arid regions.
2. Test samples of various building materials to see how porous they are.

Study Problems and Exercises

1. What in the picture on page 29 would make you conclude that the region is a rainy one? (*The steep roofs.*)
2. If you live in a region where there is much snow, would you build your house with a flat or with a steep roof? Why? (*P. 30, ¶ 1*)
3. If you live where there is much rain, which of these two building materials would you use—adobe or glazed brick? Why? (*P. 30, ¶¶ 3-4*)
4. What is the purpose of using lath in the walls of a brick house? (*P. 30, ¶ 4*)

VII. BUILDING TO FIT TEMPERATURE CONDITIONS

(pages 30-33)

Core Ideas

Many devices have been worked out to keep heat from escaping from buildings by conduction, convection, or radiation during cold weather.

Devices which serve to shut heat in also serve to shut it out during hot weather.

In hot, moist regions devices for preventing the entrance and escape of heat are not useful.

Many modern buildings are air conditioned.

Possible Approach

Call attention to the pictures on pages 31 and 33. Ask the class to discuss the two types of houses from the standpoint of how they meet the temperature conditions indicated in the pictures. Compare the Koryak house with the Eskimo igloo. Check the ideas presented by reading the first five paragraphs of the section.

Activities

1. Follow suggestion No. 11 on page 36 of the unitext.
2. Make a collection of materials used for insulation. Your local hardware dealers may be able to help you.
3. Demonstrate for yourself that heat travels by conduction, convection, and radiation. The unitext HEAT will show you ways of doing so.
4. Find out about some of the common heating systems for homes.
5. Show that snow is a poor conductor of heat.
6. From firms dealing in them get material about air conditioning systems.

Study Problems and Exercises

1. Both the Eskimos and the Koryaks live in a region where there is a great deal of snow. Tell one reason why the Eskimos do not build houses like those of the Koryaks. (*Wood not available to Eskimos.*)
2. What is the purpose of the funnel-like platform on top of a Koryak house? (*Keeps snow from drifting over the smoke hole.*)
3. Do the Koryaks spend much time shoveling snow away from their houses? Why or why not? (*No. P. 31, ¶ 1*)
4. Why is the Chama Indian house without walls? (*P. 31, ¶ 3*)
5. Explain why some hot, dry regions have houses with very thick walls. (*P. 31, ¶ 4*)
6. List four common insulating materials. (*P. 32, ¶ 2*)
7. Since air is a very poor conductor of heat, why is not an air space between the inner and outer walls a good insulator? (*P. 32, ¶¶ 3, 4*)

8. How can loss of heat by convection currents be prevented? (*P. 33, ¶ 1*)

9. Name one material which can be used to prevent the escape of heat by radiation. (*Aluminum*)

VIII. PROVIDING FOR LIGHT AND AIR (pages 34-35)

Core Ideas

In modern buildings much emphasis is being put on providing plenty of sunlight.

Devices have been worked out for admitting light without glare.

Window materials have been developed which are superior to glass in that they let ultra-violet rays pass through them.

Provision must be made in all buildings for admitting fresh air.

Possible Approach

Call attention to the heading of the section. Raise the question of what houses pictured in the book are unsatisfactory from those standpoints. Ask what point the pictures on pages 34 and 35 are designed to bring out. Check by reading the first paragraph of the section.

Activities

1. Make a collection of materials used to permit light to enter buildings.
2. Find and read about some of the beautiful stained glass windows of historic times.
3. Observe the churches in your community to see their stained glass windows.
4. Find pictures of buildings designed to let in a great deal of light.
5. Experiment with a ventilating box similar to the one pictured on page 22 of the unitext HEAT.

Possible Approach

1. In what two ways could you reduce the amount of light and heat entering a room like that on page 35? (*P. 34, ¶ 3*)
2. What is one disadvantage in using glass for windows? (*P. 34, ¶ 4*)

3. Name two materials that can be used in place of glass. (*Quartz and plastic*)

4. In what three ways can air be admitted to a house with glass brick windows, like that on page 34? (*P. 35*)

Materials and Equipment

(See page 405)

Wooden building blocks 5, 6
Metal building set 6
Ventilating box 4
Brass ring and ball 4
Compound bar 4
Conductometer 4
Thermometer 4
Convection box 4
Air thermometer tubes,
  1 black, 1 clear glass 4
Small tin pan 1
Asbestos 4
Picture or model of Leaning Tower 4
Pictures of buildings, bridges, etc.
Rock wool
Various kinds of building stone and other building materials
Materials for making concrete:
  sand, cement, and gravel
Wooden chalk boxes
Touch paper 4
Modeling clay 5
Plaster of Paris 1
Hydrochloric acid 4
HEAT
MACHINES
SOUND
STORIES READ FROM THE ROCKS

SUPERSTITION OR SCIENCE

(Note general information page 5)

I. Unfounded Beliefs (pages 3-7)

Core Ideas

There are many unfounded beliefs that are widely held.

Some unfounded beliefs are thought to have come from poor observation.

Some unfounded beliefs are thought to have come from mistakenly ascribing a cause-and-effect relationship to two happenings.

Possible Approach

Explain that one of the reasons for studying science is to help people outgrow their superstitions. Lead the class to tell of any superstitions they know about. Let them identify the superstitions suggested by the cartoons on pages 4 and 5. Discuss the difference between such ideas and scientific beliefs. Call attention to the picture on page 2 and ask for suggestions as to why that picture should be included in a book called Superstition or Science. What kind of belief does it illustrate? Ask the class to check the suggestions made by reading the first four paragraphs of the section. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activities

1. Choose some unfounded belief and suggest ways in which it may have come into existence.
2. Ask five persons not in your science class what they think brings them good luck.
3. Follow suggestion No. 1 on page 36 of the unitext.

4. Follow suggestion No. 2 on page 36 of the unitext.

5. Follow suggestion No. 3 on page 36 of the unitext.

6. Many newspapers print daily horoscopes. Examine them to see whether you think any dependence should be put on them.

7. From talking with other people make a list of superstitions not mentioned in the book.

Study Problems and Exercises

1. "Music charms snakes." *"Snakes are deaf."* The account on page 3 backs up one of these two beliefs. Underline the one it backs up.

2. The sketches on pages 4 and 5 suggest fourteen rather widely held beliefs. What two names could you give to all these beliefs? (*Superstitions, or unfounded beliefs.*)

3. The sketches on pages 6 and 7 suggest thirteen other beliefs in which, scientists think, there is no truth. The last paragraph on page 7 tells two ways in which such beliefs might have come about. Name the two ways and list under each any five of the beliefs that you think may have come about in that way. State the beliefs in full sentences.

II. THE SCIENCES (pages 9-10)

Core Ideas

Science is made up of "founded beliefs."

Science is based on careful observations, accurate records, exact measuring, and painstaking experiments.

There are many separate sciences, some much older than others.

Scientific knowledge is made up of facts, principles, and theories.

The sciences may be divided into basic and applied sciences.

Possible Approach

Ask some member of the group to look up the word "science" in a dictionary which gives derivations to find out from what word "science" is derived. Then raise the question of how the "knowing" has come about—of how the sciences have been built up. Ask the class to check its conclusions by reading the first paragraph on page 9.

Activities

1. Make an alphabet of branches of science; that is, try to find at least one science beginning with *a,* one with *b,* and so on.

2. Plan an experiment or activity of your own to demonstrate before the class some scientific principle.

3. Make a tree similar to the one on page 8 for applied sciences.

Study Problems and Exercises

1. The tree on page 8 names a science which deals, at least in part, with each of the things listed below. After each item in the list write the name of the science that deals with it.

animals of long ago (*paleontology*), weather (*meteorology*), heavenly bodies (*astronomy*), light (*physics*), the parts of the body (*physiology*), early man (*anthropology*), animals (*zoology*), plants (*botany*), the earth (*geography*), bacteria (*bacteriology*), changes in the earth's surface (*geology*), chemicals (*chemistry*), problems involving numbers (*mathematics*).

2. Identify each of the following as facts, principles, or theories:

1) A squirrel is a mammal. (*F*)
2) Oxygen is a gas. (*F*)
3) Opposite magnetic poles attract each other. (*P*)
4) All living things of today came from the very simple living things that first lived on the earth. (*T*)
5) Air exerts pressure. (*P*)
6) Evaporation is a cooling process. (*P*)
7) Measles is a disease. (*F*)
8) In general substances expand when heated and contract when cooled. (*P*)
9) In the course of many millions of years the sun will lose its heat. (*T*)
10) The air extends upward for many miles above the earth's surface. (*F*)

3. Give a good example, not given above, of each of the following:

A scientific fact   A scientific principle   A scientific theory

4. List four ways in which the science of zoology has been built up. (*P. 9. ¶ 1*)

5. Identify each of the following as a basic science or an applied science:

zoology (*B*), forestry (*A*), medicine (*A*), surveying (*A*), physiology (*B*), agriculture (*A*), astronomy (*B*), animal breeding (*A*), botany (*B*), electrical engineering (*A*).

III. NATURE MYTHS, FORERUNNERS OF SCIENCE (pages 11-13)

Core Ideas

Nature myths represent attempts to answer questions about natural phenomena.

Nature myths are, therefore, the forerunners of science.

Possible Approach

Read to the class some Greek or Roman nature myth—the story of the Royal Family, for example. (This story may be found in the unitext BEYOND THE SOLAR SYSTEM.) Ask the class to discuss the reason for calling such nature myths forerunners of science. Let them check their ideas by reading the first two sentences of the section.

Activity

Follow suggestion No. 8 on page 36 of the unitext.

Study Problems and Exercises

1. What two questions about their surroundings did the Ojibway Indians explain for themselves by the myth told on pages 11 to 13? (*P. 11,* ¶ 1)

2. Why should nature myths be called the "forerunners of science"? (*P. 13,* ¶ *6*)

IV. MILESTONES IN SCIENCE HISTORY (pages 14-20)

Core Ideas

The sciences of today have been built up through the work of many thousands of people.

The discoveries of some scientists have been so important that they may be considered as milestones in science history.

Possible Approach

Call the attention of the group to the title of the section. Ask the members of the group to name any scientific discoveries they know about which they think are sufficiently important to be called "milestones."

Activities

1. Read in other books a fuller account of the lives and work of the scientists mentioned in the unitext.
2. Make an alphabet of scientists.
3. Follow suggestion No. 6 on page 36 of the unitext.

Study Problems and Exercises

1. Draw lines joining the name of each scientist with the sentence telling of some scientific work he did or discovery he made.

Tycho Brahe	He discovered that the earth acts like a huge magnet.
Gilbert	He observed the positions of the planets for many years.
Priestley	He worked out laws of heredity.
Faraday	He used magnets to get a current of electricity.
Harvey	He discovered oxygen.
Mendel	He discovered the path of the blood in our bodies.

2. Make a good title for the picture on the outside cover of the book. (*P. 18, ¶ 4*)

3. Make a good title for the picture on the inside front cover. (*P. 19, ¶ 1*)

4. Make a good title for the picture on the inside back cover. (*P. 19, ¶ 2*)

5. Name some discovery not illustrated in the book that you would consider a milestone in science history.

V. Science Today (pages 21-29)

Core Ideas

Some scientists of today are working directly on problems that need solving at once.

Some scientists are interested in adding to the fund of scientific knowledge without any concern as to whether their discoveries will have immediate practical applications.

Solving one problem may make new problems arise.

Scientists now have a great many scientific instruments that help them with their work.

Possible Approach

Have a collection of scientific tools and instruments arranged on the demonstration table and numbered, not named. Let the members of the group try to identify each tool or instrument and tell of what use it is. After checking together, ask what bearing this activity has on the section "Science Today." Check by reading the paragraph at the bottom of page 28.

Activities

1. Follow suggestion No. 4 on page 36 of the unitext.
2. Follow suggestion No. 5 on page 36 of the unitext.
3. Follow suggestion No. 7 on page 36 of the unitext.
4. Make a collection of pictures of scientific tools and instruments for exhibit purposes.

Study Problems and Exercises

1. State in a full sentence the problem suggested by the picture on page 21. (*How can sea water be made fit to drink?*)

2. State two scientific facts which scientists used in solving the problem. (Any two: *Water evaporates when heated. Water vapor condenses when cooled sufficiently. Salt does not change to vapor when heated.*)

3. State at least three problems suggested by the picture on page 22. (*P. 23, ¶¶ 1 and 2*)

4. What problem is suggested by the picture on page 23? (*Of what use to cypress trees are their knees?*)

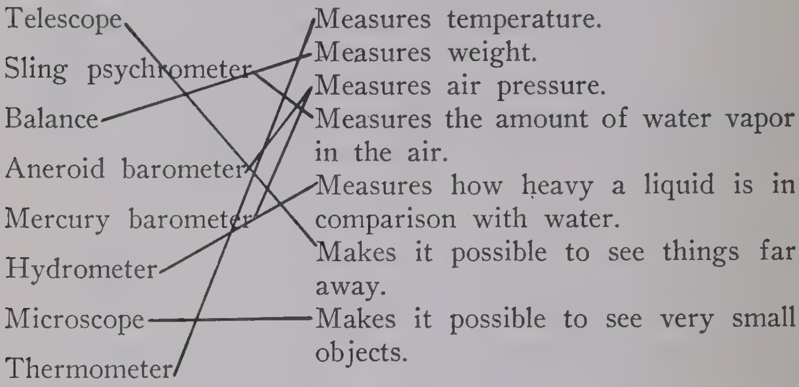
5. State one way in which the problem suggested by the picture on page 23 differs from the problems suggested by the picture on page 22. (*The solutions to the problems on page 22 are of immediate practical significance; the solution to the problem on page 23 is not.*)

6. Solving one problem may bring about the necessity for solving another problem. Give an example.
First problem: (*P. 24, ¶ 3*) Second problem: (*P. 25, ¶ 1*)

7. Condense into one paragraph the story of fighting malaria during World War II.

8. What very important problem does the picture on page 27 suggest? (*How can soil be kept fertile?*)

9. Draw lines to match the names of the tools listed with the statements of their uses.



Telescope
Sling psychrometer
Balance
Aneroid barometer
Mercury barometer
Hydrometer
Microscope
Thermometer

Measures temperature.
Measures weight.
Measures air pressure.
Measures the amount of water vapor in the air.
Measures how heavy a liquid is in comparison with water.
Makes it possible to see things far away.
Makes it possible to see very small objects.

VI. Science and You (pages 30-34)

Core Ideas

Science is not only a body of facts, principles, and theories, but also a way of thinking.

The way scientists work out the solutions to problems is spoken of as the scientific method of problem solving.

Scientific method can be analyzed into steps.

Every individual has many opportunities to use the scientific method of problem solving whether or not he is a scientist.

Possible Approach

Lead the class to recall the earlier discussion of science as a vast accumulation of facts, principles, and theories—a great body of knowledge. Point out that there is another definition of science. Let the class find by reading the first two paragraphs of the section what it is.

Activities

1. Follow suggestion No. 9 on page 36 of the unitext.

2. Follow suggestion No. 10 on page 36 of the unitext.

3. Find in the story of some famous scientist such as Pasteur, Galileo, Trudeau, or Lavoisier the account of some discovery the scientist made, and identify the steps of problem solving which he followed.

4. Choose some problem and plan its solution, identifying each of the steps of problem solving.

5. Write up a story of an imaginary experiment, being sure that there is one noticeable error in the plan, and ask the other members of the group to identify the error.

6. *Natural History* for April, 1942 (No. 110, Guide Leaflet Series, American Museum of Natural History), has an article, "The Great Animal Invasion," which lists several hypotheses for the fact that we have failed to find the ancestors of *Eohippus,* the dawn horse, in North America. Read it to get a better idea of how a number of hypotheses may be formulated in the solving of a problem.

Study Problems and Exercises

1. Copy in one column the seven steps listed on page 32. Then choose some problem you have solved and match the steps with those in the list.

2. Here is an account of an experiment. What do you need to know that the account does not tell you, in order to decide whether the experiment was a good one?

John had two young hamsters, Pete and Mike. He wanted to find out whether it was important to include milk in a hamster's diet. He fed Pete a mixture of dried milk, whole-wheat flour, wheat germ, and cod liver oil. He also gave him fresh lettuce every day and a few bits of dog biscuit. He fed Mike the same things except that milk was omitted. At the end of a month Pete weighed ten grams more than Mike, and John decided that milk should be included in a hamster's diet.

(*You do not know how the weights of the hamsters compared at the beginning of the experiment.*)

3. One of the problems which everyone your age needs to solve for himself is how many hours of sleep he needs each night. How would you go about solving this problem? (*You would vary the number of hours of sleep and keep a careful record of how well and energetic you felt and how well you accomplished what was expected of you next day in each case. You would check your conclusion by repeating the experiment.*)

Summary Exercise

Mark each of these statements true or false. After each tell the page in the book on which you find backing for your decision.

Page

C 1) Agriculture is an applied science. (*10*)

X 2) A hypothesis is made after the conclusion from an experiment is drawn. (*32*)

X 3) When you have tested your conclusion once, you have removed all doubt about your findings. (*34*)

X 4) Botany is an older science than astronomy. (*9*)

C 5) Solving one scientific problem may make it necessary to solve another scientific problem. (*25*)

C 6) Many unfounded beliefs are widely held. (*4*)

X 7) Science is made of unfounded beliefs. (*9*)

C 8) Nature myths are considered forerunners of science. (*11*)

C 9) The sciences of today have been built up through the work of many thousands of people. (*14*)

X 10) No scientist is interested in working on a problem if its solution will not have any immediate practical applications. (*24*)

C 11) Science is not only a body of facts, principles, and theories, but also a way of thinking. (*30*)

C 12) The way scientists work out the solutions to problems is spoken of as the scientific method of problem solving. (*31*)

C 13) Scientific method can be analyzed into steps. (*32*)

C 14) Honesty is one of the characteristics of a good scientist. (*33*)

X 15) If a person is not a scientist, it is a waste of time for him to learn to use the scientific method of problem solving. (*30*)

Materials and Equipment

(See page 405)

BEYOND THE SOLAR SYSTEM
THE SCIENTIST AND HIS TOOLS
Science News Letter
Natural History, April, 1942
Scientific instruments of various kinds

Flask 4
Gas burner 4
2 thermos bottles 1, 3
Thermometer 4

THE SUN AND ITS FAMILY

(Note general information page 5)

I. Introduction (pages 3-4)

Core Ideas

The earth is a member of the solar system.

The solar system consists of the sun and the heavenly bodies which travel in space around the sun.

In the solar system there are one star (the sun), planets, meteors, moons, comets, and planetoids.

Possible Approach

Ask the class to tell of any experiences they may have had with traveling at high speed. What sensations did they have when they were going very fast? Then ask how many of them would like to travel at a speed of 1,000 miles a minute. After they have answered, give out copies of The Sun and Its Family and let them read the first paragraph on page 3. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activity

The sun is roughly 93,000,000 miles away from the earth. If you could travel to the sun in some machine at the rate of 100 miles an hour, how long would it take to reach the sun? (*106+ years*)

Study Problems and Exercises

1. Cross out the word which does not belong in this sentence: "The solar system consists of the sun and the planets, *stars,* comets, meteors, planetoids, and moons."

2. During one of your science periods, about how far does the earth travel in its path around the sun? (*P. 3, ¶ 1*)

II. Two Whys (pages 5-6)

Core Ideas

The sun's gravity keeps the earth from going out into space away from the sun.

The rapid movement of the earth keeps the earth from falling into the sun.

The same forces hold the other members of the solar system on their paths.

Possible Approach

Draw a small circle on the board to stand for the sun. Draw a circle around it to stand for the earth's orbit. Raise the question of why the earth should follow this same path year after year. Make the class see that there are really two problems: Why doesn't the earth ever come closer to the sun? Why doesn't the earth run away from the sun? After the class has expressed any ideas they may have, let them check by reading the first six paragraphs of "Two Whys."

Activity

Do this experiment out of doors. Fasten a ball of clay about two inches in diameter to the end of a string about four feet long. Hold the other end of the string, and swing the ball in a circle around your head. Notice that, although you are pulling on the string, the ball stays out as far as the string will let it go. While the ball is moving fast in a circle, let go of the string. What happens? (*Ball flies a considerable distance away.*) What does the string represent? (*Gravity*)

Study Problems and Exercises

1. What keeps the planets in their paths? Tell why they do not fall into the sun as well as why they do not move away from the sun out into space. (*P. 5, ¶¶ 3 and 5*)

2. Arrange these three planets in the order of their speed as they travel around the sun. Put the slowest one first.

(3)	(1)	(2)
Earth	Pluto	Mars

III. The Sun Itself (pages 6-9)

Core Ideas

The sun is a medium-sized star, but it is much larger than the earth.

The sun is very hot.

Sunspots are storms on the sun's surface.

If it were not for the sun, life on the earth would be impossible.

Possible Approach

Call the attention of the class to the pictures on pages 7, 10, and 11. Let them try to explain the pictures. Then let them check their explanations by reading the second paragraph on page 7 and the third, fourth, and fifth paragraphs on page 8.

Activity

Follow suggestion No. 6 on page 36 of the unitext.

Study Problems and Exercises

1. Sir William Herschel, a famous astronomer who lived from 1738 to 1822, thought that the sun was probably inhabited. Tell two facts about the sun which astronomers had apparently not found out at the time Sir William Herschel lived. (*Too hot; gaseous*)

2. How do scientists know that the sun is turning on its axis? (*P. 8, ¶ 1*)

3. Explain the picture on page 11. What are the dark disk that you see, the deep-rose "flames," and the "halo"? (*Moon; prominences; corona*)

IV. THE NINE PLANETS (pages 9-12)

Core Ideas

The planets shine only by reflected light.

In some ways all planets are alike; in other ways they differ from one another.

Possible Approach

Reread with the class the third paragraph on page 3. Let the class try to tell the chief difference between a star and a planet. Have them check their ideas by reading the first paragraph on page 10.

Activities

1. Examine the diagrams on the chart which goes with this unitext. What does each diagram show? (The chart may be obtained without charge from the publishers.)

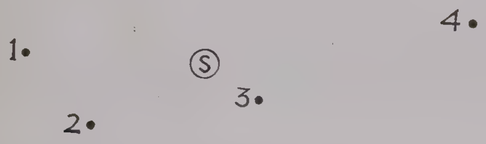
2. Follow suggestion No. 1 on page 35 of the unitext.

3. Follow suggestion No. 2 on page 35 of the unitext.

4. Follow suggestion No. 4 on page 36 of the unitext.
5. Follow suggestion No. 5 on page 36 of the unitext.

Study Problems and Exercises

1. These dots represent the sun, Mercury, Venus, the earth, and Mars. The sun is marked, as you see. Tell for what planet each number stands. (1—*Earth;* 2—*Venus;* 3—*Mercury;* 4—*Mars*)



2. What does the word "planet" mean? Why is it a good name for the heavenly bodies for which it is used? (*P. 9, ¶ 2*)

V. Mercury; VI. Venus (pages 12-15)

Core Ideas

The absence of atmosphere and the temperatures on Mercury make life as we know it impossible there.

Mercury and Venus have phases just as the moon has, because their paths are between the earth's path and the sun.

Because of the clouds surrounding Venus, scientists have not been able to find out much about conditions on the surface of Venus.

Possible Approach

Call the attention of the class to the diagrams on page 13 and the picture on page 15. Let the class try to explain these diagrams. Have them check by reading the last paragraph on page 12, the first paragraph on page 13, and the last paragraph on page 14.

Activity

Follow suggestion No. 3 on page 36 of the unitext.

Study Problems and Exercises

1. Why are Mercury and Venus the only planets that seem to change their shape just as the moon does? (*Only planets between earth's path and the sun.*)

2. Why did the ancient Greeks give both Mercury and Venus two names? (*P. 12, ¶ 2; p. 14, ¶ 5*)

3. Why do we not know whether it would be possible for there to be any life on Venus? (*P. 15, ¶¶ 2 and 5*)

VII. THE BEST-KNOWN PLANET (pages 16-19)

Core Ideas

The rising and setting of the sun, moon, and stars are due to the rotation of the earth on its axis.

The seasons are caused by the traveling of the earth around the sun and by its rotation on an axis which is always tilted toward the North Star.

The rotation and the revolution of the earth have given us our fundamental units of time—the day and the year.

So far as we know, the earth is the only inhabited planet.

Possible Approach

Call the attention of the class to the heading of the section. Let them write in five minutes as many of the things they know about the earth as a whole as they can. Discuss their lists before reading the section.

Activities

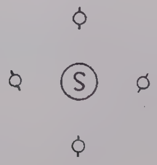
1. Follow suggestion No. 8 on page 36 of the unitext.

2. Follow suggestion No. 1 under Activities on page 92 of this manual.

3. Follow suggestion No. 3 under Activities on page 92 of this manual.

Study Problems and Exercises

1. What is wrong with this diagram of the earth's revolution around the sun? (*Axis should always be tilted at same angle.*)



2. Use these words in sentences to show that you understand what they mean: revolution, rotation, axis.

3. If the earth traveled around the sun as it does now, but with its axis not tilted, what season would we now be having? (*P.18, ¶3*)

VIII. MARS; IX. JUPITER; X. SATURN; XI. URANUS; XII. NEPTUNE; XIII. PLUTO (pages 19-27)

Core Ideas

Conditions on Mars are very different from conditions on the earth, although Mars has some air and perhaps some water.

There are some puzzling questions about Mars that are still unsolved.

Conditions on Jupiter, Saturn, Uranus, Neptune, and Pluto are such that no life of the kind we know could exist there.

Perhaps there are still undiscovered planets in our solar system.

Possible Approach

Call the attention of the class to the pictures of Mars, Jupiter, and Saturn on pages 19, 22, and 23. Ask how, with a telescope, one can tell these three planets apart. Let the class give any suggestions they can as to what the white cap on Mars, the bands on Jupiter, and the rings on Saturn are. Have them check by reading the fourth paragraph on page 19, the first and second paragraphs on page 22, and the third paragraph on page 23.

Activity

Make models of the sun and the planets and their moons. Make the sun of cardboard and the planets and moons of modeling clay. Hang them up to show the order of the planets from the sun. The table on page 12 and the diagrams on pages 8 and 9 will be helpful.

Study Problems and Exercises

1. Each of the following phrases describes one of the nine planets in our solar system. Copy the phrases and write after each phrase the name of the planet described.

1) The planet with the rings. (*Saturn*)
2) The planet discovered by Herschel. (*Uranus*)
3) The planet we know most about. (*Earth*)
4) The planet which travels fastest. (*Mercury*)

5) The planet with the big red spot. (*Jupiter*)
6) The most recently discovered planet. (*Pluto*)
7) The giant planet with one moon. (*Neptune*)
8) The third-brightest object in the sky. (*Venus*)
9) The planet on which some astronomers think they have seen canals. (*Mars*)

2. Write in a column the names of the six planets in our solar system which scientists are sure could not possibly be inhabited by people like us. After each name you have written, write one reason why that planet could not possibly be inhabited.

3. What has led some people to believe that Mars is inhabited? (*Canals*)

4. If the picture on page 19 were not labeled, how would you know that it is a picture of Mars? (*White cap*)

5. What is the point of the cartoon on page 20? (*P. 20, ¶ 1*)

6. What is the point of the cartoon on page 21? (*P. 22, ¶ 5*)

7. What two planets can never be seen without a telescope? (*Neptune and Pluto*)

XIV. THE PLANETOIDS (pages 27-29)

Core Ideas

Planetoids differ from planets only in the matter of size.

Conditions on the planetoids make life of the kind we know impossible there.

Possible Approach

Reread with the class the last three sentences of the third paragraph on page 3. Explain that most of these many planetoids have paths between the orbits of Mars and Jupiter. Encourage the class to suggest a reason for there being so many tiny planets between these two orbits. Let them check their suggestions by reading the first paragraph on page 29.

Activity

Write an imaginary story of a trip to some planetoid.

Study Problems and Exercises

1. One of the cartoons in the book is meant to tell something about a planetoid. Which cartoon is it, and what does it tell? (*Cartoon on p. 29—see p. 28, ¶ 2*)

2. On pages 27 and 28 ten heavenly bodies are mentioned by name. List them. Then divide them into four groups and put a

suitable heading at the top of each group. (*Stars—sun; Moons—our moon; Planets—Pluto, Mars, Jupiter, earth; Planetoids—Eros, Ceres, Amor, 1932 H.A.*)

XV. COMETS (pages 29-31)

Core Ideas

The orbits of comets differ in shape from the orbits of planets.

In earlier times people had the false idea that comets were forerunners of disaster.

Possible Approach

Call the attention of the class to the picture on the inside covers. It is the same picture which is shown in outline on page 32. Tell them that *Istimirant Stella* means "amazing star," and ask them to find the "amazing star" in the picture. How does the picture show that the "star" is really a comet, not a star? (*It has a tail.*) Have the class read the third paragraph on page 29 to find out what the picture is.

Study Problems and Exercises

1. What is the diagram on page 31 meant to show? (*That the tail of a comet always streams out away from the sun*)
2. There are probably fewer comets now than there were a million years ago. Why? (*P. 31, ¶ 5*)
3. How old will you be when the comet pictured on the inside covers next appears? (*In 1986*)

XVI. SHOOTING STARS AND FIREBALLS (pages 32-34)

Core Ideas

Meteors are visible only after they enter the earth's atmosphere.

Meteors are thought to be pieces of broken-up comets.

Shooting stars and fireballs differ only in the matter of size.

Possible Approach

Encourage the class to tell of any experiences they have had with meteors and meteorites. Let them try to tell why the trail of the shooting star in the picture on page 4 is brightest in the middle. (*The meteor has to fall some distance through the air before it gets very hot, and it is destroyed rapidly after it becomes white-hot.*)

Activity

Follow suggestion No. 7 on page 36 of the unitext.

Study Problems and Exercises

1. Is it correct to say that there are millions of shooting stars traveling around the sun? Why or why not? (*No—see p.32,* ¶ *4*)

2. Explain the picture on page 35. (*P.33,* ¶ *4*)

XVII. How Our Solar System Began (pages 34-35)

Core Ideas

Different scientists have different theories about the beginning of the solar system.

Most of these theories state that all the material in the members of the sun's family came originally from the sun itself.

Possible Approach

Explain to the class the difference between a fact (something that can be proved) and a theory (an explanation that seems to fit the facts but that cannot be proved). Tell the class that any explanation of how the solar system began must be a theory, and ask why. Let the class check their explanation by reading the first paragraph of "How Our Solar System Began."

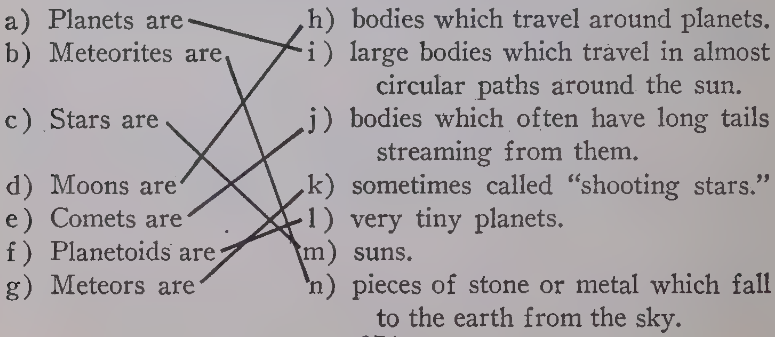
Study Problems and Exercises

1. Read again the last five sentences on page 6. How does the story of the beginning of the solar system explain why the same materials are found in the earth and the sun?

2. "The earth came from the sun." Add any words to this sentence which you need to add to make the sentence accurate. (*Most scientists believe that—*)

Summary Exercises

1. Match the following parts of sentences so that you have seven true statements. Copy the seven statements.



a) Planets are
b) Meteorites are
c) Stars are
d) Moons are
e) Comets are
f) Planetoids are
g) Meteors are

h) bodies which travel around planets.
i) large bodies which travel in almost circular paths around the sun.
j) bodies which often have long tails streaming from them.
k) sometimes called "shooting stars."
l) very tiny planets.
m) suns.
n) pieces of stone or metal which fall to the earth from the sky.

2. Mark each of the following sentences "True" or "False."

C (1) The earth is a member of the solar system.

X (2) The surface of the sun is always exactly the same.

X (3) Scientists know exactly how our solar system began.

C (4) Our sun is only one of an enormous number of suns.

C (5) The turning of the earth on its axis gave us one of our measures of time—the day.

C (6) The traveling of the earth around the sun gave us another measure of time—the year.

X (7) Pluto gets much more light and heat from the nearest star than it gets from the sun.

X (8) Shooting stars are real stars.

X (9) There are many shooting stars in museums.

C (10) People used to think that the appearance of a comet was a warning of disaster.

X (11) Comets always remain the same shape and size.

X (12) Comets are very small.

X (13) The paths of the comets are exactly like the paths of planets.

C (14) At the time of an eclipse of the sun, the sun's corona may be seen.

X (15) During summer in the Northern Hemisphere we are much closer to the sun than during our winter.

3. Suppose the earth were the only member of the sun's family. What differences would it make to us? (*Almost no tides; no moonlight; no eclipses; no "morning" and "evening stars"; etc.*)

Materials and Equipment

(See page 405)

Almanac
Small marbles or ball bearings
Table-tennis ball
Small telescope 4
Weather report from newspaper
Globe 5
Lamp
Modeling clay—yellow and gray 5
String (4 feet long)
Cardboard (at least 27"x 27")

WATER SUPPLY

(Note general information page 5)

I. A MIDWESTERN CITY AND ITS WATER SUPPLY; II. THE STORY OF NEW YORK'S WATER SUPPLY

(pages 3-7)

Core Idea

Providing an adequate water supply may constitute a serious problem for a community.

Possible Approach

Raise the question of what problems a community is likely to meet when it undertakes to furnish a satisfactory supply of water to all its members. Let the class find by reading the story of Springfield's water supply whether the problems this city had to meet were among those listed by the class. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activity

If you live in a community which has a public water supply system, find out all that you can about the history of the system and write a story about it similar to the stories of the systems of Springfield and New York

Study Problems and Exercises

1. Check each of the following sentences which correctly describes a step in Springfield's progress toward building a safe and adequate water supply.

(✓) In 1837 Springfield, a village of 2,000 people, had one public well.

(√) In 1845 the city built new wells and placed a hand pump at each of the four corners of the public square.

( ) Later, to help the city become an industrial center, several artesian wells were successfully built.

( ) A fire-fighting tournament was held in 1863, for which huge amounts of water were made available by building many large cisterns.

(√) A pumping station was built to bring water from the Sangamon River.

(√) Later thirty large wells were dug near the Sangamon River.

( ) Soon afterward chlorine was added to soften the water.

(√) Because the city again outgrew its water supply, a large artificial lake was built in 1935.

2. Mark these sentences true or false.

X (1) Since New York is surrounded by three rivers and the ocean, it has no important water problems.

C (2) In 1840 New York was getting practically all its water from wells and cisterns.

C (3) In early days, because the well water was salty and unsafe, many New Yorkers bought spring water by the pailful.

C (4) In 1842 an aqueduct was built to bring water to the city.

C (5) Fifty years later a new aqueduct was completed.

C (6) Reservoirs were built in connection with the aqueducts.

X (7) The Catskill Aqueduct, completed in 1928, will supply New York with adequate amounts of water for many years to come.

C (8) A part of the Catskill Aqueduct is about a thousand feet below sea-level.

C (9) New York is now building an even larger water supply system.

X (10) New York allows people to use the reservoirs for boating or bathing.

C (11) New York does not have to pump its water to the city.

X (12) A water supply system such as New York's can be built very cheaply.

III. NEEDS FOR WATER (pages 8-10)

Core Ideas

A city's needs for water may be grouped under these headings: public needs, household needs, and industrial needs.

The per capita consumption of water in different communities may differ greatly.

In general per capita consumption of water in cities has increased greatly in the past hundred years.

Possible Approach

Read together the first paragraph of the section. Let the class attempt to answer the question with which it ends. Check the list of uses suggested by a brief survey of the section.

Activities

1. Try to find out the total amount of water your city or town uses each day. Figure the daily per capita consumption of water.
2. Keep as accurate a record as you can of the amount of water used in your home during a day.
3. If you have a leaky faucet at home or at school, measure the amount of water lost by it in an hour or in a day.
4. Collect pictures showing important uses of water.
5. Make a list of five important industries in your community and find out how important a part water plays in them.
6. In HEAT, another unitext, find diagrams of steam and hot-water heating systems.

Study Problems and Exercises

1. List ten needs for water in a city and group them under appropriate headings. (*P. 8, ¶ 2*)
2. The fire insurance rates in City A are much higher than those in City B. Suggest a probable reason. (*P. 8, ¶ 4*)
3. Tell in one sentence the story told by the graph on page 10. (*P. 10, ¶ 1*)
4. Name three things which affect a city's need for water. (*P. 9, ¶ 2*)

IV. SOURCES OF WATER (pages 10-14)

Core Ideas

Some communities depend on ground water, some on surface water, and some on both ground water and surface water for their supplies.

It is practically impossible for a large city to get its entire supply of water from wells or springs—that is, from underground.

Large cities must, therefore, depend at least in part on surface supplies—on rivers, lakes, or artificial reservoirs.

Possible Approach

Ask the class where the water they use comes from. Then let them suggest other possible sources of water for a community. As sources are named, list them on the blackboard in two columns—those which supply surface water and those which supply ground water. Ask the class to try to tell the basis for classifying them. Check by reading the first paragraph of the section.

Activities

1. Build a series of models showing possible sources of water.

2. Devise a set-up to show why water in many cases flows from an artesian well without being pumped.

3. Choose ten widely scattered cities in the United States. Find them on a map. Guess from their location what the source of the water supply is. Find out by writing to the water supply department of the cities how good your guesses were.

Study Problems and Exercises

1. Fill in the blank spaces: Wells gather (*ground*) water. Streams gather (*surface*) water. In Ohio 75 per cent of the public water supplies come from (*wells*). The left-hand diagram on page 11 shows a (*shallow*) well. Families which have this type of well often have a (*cistern*), too, for collecting surface water. The level at which underground water stands is called the (*water table*). After a heavy rain it (*rises*) and during a dry period it (*falls*).

2. Make a simple diagram to show that you understand the conditions necessary for an artesian well. Color blue the layer of rock which carries the water. Color brown the layers which must be nonporous. Color yellow layers which may be either porous or nonporous.

3. The diagrams on page 11 show one advantage which an artesian well may have over a shallow well. What is it? *(P. 12, ¶ 3)*

4. List four natural sources of surface water supplies. For each name a city which depends on that source.

1) *(Mountain streams—New York City)*
2) *(Lowland streams—Springfield, Ill.)*
3) *(Large rivers—St. Louis)*
4) *(Natural lakes—Cleveland)*

V. IMPURITIES IN WATER (pages 14-17)

Core Ideas

To be satisfactory water should be safe to drink, clear and colorless, free from disagreeable taste and odor, and reasonably soft.

Among the impurities found in water are mud, tiny living organisms, decaying organic material, dissolved minerals, wastes from industrial plants, and dissolved gases.

Ground water, if not contaminated by surface water, is likely to be more free from mud, germs, and industrial wastes than surface water but to contain a higher percentage of minerals.

Water, although clear and sparkling, may contain disease germs and therefore be dangerous.

The first step a community should take toward purifying its water supply is to analyze the water and find out what impurities are present.

Possible Approach

Draw a bottle full of water from the faucet and stand it on the demonstration table. Ask the class what evidence they get from looking at the water as to whether the water supplied to the community is satisfactory. Then ask what other points would have to be considered in rating the quality of the water. Check the suggestions by reading the first two paragraphs of the section.

Activities

1. Follow suggestion No. 1 on page 36 of the unitext.

2. Get a sample of hard water and a sample of soft water. Place an equal amount of soap in each. Which sample produces the best lather? (You can make soft water hard by adding calcium or magnesium carbonate from your school science laboratory.)

3. Follow suggestion No. 2 on page 36 of the unitext.

4. Follow suggestion No. 3 on page 36 of the unitext.

5. Follow suggestion No. 4 on page 36 of the unitext.

Study Problems and Exercises

1. What four standards should the water furnished to a community meet? Number them as you list them. (*P. 14, ¶ 2*)

2. Below is a list of some of the impurities which are often found in drinking water and which make the standards mentioned in Exercise 1 difficult to meet. In the blank spaces tell by number, using the numbers you used in Exercise 1, what standard or standards the impurity makes it difficult to meet.

____________________ Mud

____________________ Tiny living organisms

____________________ Decaying plant and animal material

____________________ Dissolved minerals

____________________ Wastes from industrial plants

____________________ Dissolved gases

3. Copy the list of impurities given in Exercise 2. Underline in red those most likely to be found in surface water. Underline in blue those most likely to be found in ground water. If an impurity is equally likely to be found in ground water and surface water, do not underline it. (*Underline in red: mud, tiny*

living organisms, decaying plant and animal material, wastes from industrial plants. Underline in blue: dissolved minerals. Do not underline: dissolved gases.)

4. Mark these statements true or false:

C (1) Some of the impurities found in water may do great harm.

X (2) Hard water has, as a rule, a very disagreeable taste.

X (3) Hard water is far better than soft water for laundry purposes.

X (4) The diagram on page 17 is a well-planned farm layout.

C (5) The first step a community should take to improve the quality of the water it furnishes its members is to analyze the water.

VI. Ways of Purifying Water (pages 18-24)

Core Ideas

Practically every public water supply needs treatment of some kind.

Among the methods of purification are storage in open reservoirs, filtration, aeration, disinfection with chlorine, addition of water-softening chemicals, and use of activated carbon.

By some combination of treatments practically any raw water can be made fit for use.

If the community water supply is not safe, water can be purified at home by boiling, filtration, or addition of certain chemicals.

Distillation is an effective way of purifying water but is too expensive to be used for large amounts of water.

Possible Approach

Ask the class what treatment, if any, their community uses to improve the quality of the water it furnishes. Add some mud and some salt to a bottle of water. Find out by experimenting whether the treatment used by the community would remove those impurities. Check the findings by reading from the text about that particular method or combination of methods.

Activities

1. Visit a water-testing laboratory.

2. Fill two bottles with muddy water. Add some alum to one of the bottles. Observe what happens to the treated water as compared with the untreated water.

3. Fill two bottles with hard water. To one bottle add a little sodium carbonate, borax, or other water softener. Add the same amount of soap to each bottle. Which produces the best lather?

4. Follow suggestion No. 5 on page 36 of the unitext.

5. Follow suggestion No. 6 on page 36 of the unitext.

6. Put a spoonful of salt in a cupful of water. Boil the water for several minutes. Does boiling the water take out the salt? Taste the water to find out.

7. Follow suggestion No. 7 on page 36 of the unitext.

8. Follow suggestion No. 8 on page 36 of the unitext.

9. Cut both ends out of a tin can. Tie a piece of white cloth over one end. Fill the can with clean sand. Now use the can filled with sand as a filter. Filter some muddy water through it.

10. Follow suggestion No. 9 on page 36 of the unitext.

Study Problems and Exercises

1. Column *A* below is a list of the steps which the city of Columbus, Ohio, takes in purifying its public water supply. These steps are not written in the proper order. Number them to show the proper order. Column *B* is a list of reasons why the steps are taken. Match the reasons with the steps by placing the number of the correct step in each blank space.

A

(*5*) The water is analyzed
(*2*) The water is made to pass through a screen
(*4*) In the pump house the water is pumped
(*7*) Alum is added
(*9*) The water is stirred gently

B

(*13*) to kill disease germs.
(*9*) to make flocs form.
(*1*) to send water to the intake house.
(*11*) to prevent trouble in water mains.
(*7*) to make the mud easier to remove.

	A		*B*
(*11*)	Carbon dioxide is added	(*10*)	to allow the flocs to settle.
(*12*)	The water goes through the rapid sand filters	(*3*)	to furnish a supply to the pump house.
(*1*)	A dam across the Scioto River serves	(*2*)	to keep out fish, leaves, etc.
(*6*)	Lime and soda are added	(*8*)	to make the chemicals work better.
(*3*)	The water flows to a suction well	(*12*)	to strain out all solid materials.
(*13*)	Chlorine is added	(*6*)	to soften the water.
(*8*)	The chemicals are thoroughly mixed with the water	(*5*)	to determine what chemicals to add.
(*10*)	The water goes to a settling basin	(*4*)	to send it to the chemical house.

2. What is St. Louis' first step in the purification of its water? (*P. 22, ¶ 4*) Why should this be the first step? (*P. 22, ¶ 4*)

3. Would St. Louis be more likely to use a rapid sand filter or a slow sand filter? (*Rapid*) Why? (*P. 22, ¶ 5*)

4. Name two methods of removing undesirable tastes and odors from water. (*P. 23, ¶¶ 2 and 3*)

5. If you live in a place where there is no public water purification system, what could you do to:
Make the water clear? (*Use a stone filter.*)
Soften the water? (*Use chemicals bought in a drugstore.*)
Make it safe? (*Boil or distil it.*)

VII. GETTING WATER TO WHERE IT IS WANTED

(pages 25-28)

Core Ideas

Distributing water to where it is needed offers problems, too.

In cities the problems center about furnishing pathways for the water, maintaining adequate pressure to force the water through the pathways provided and up into buildings, and controlling the flow of water.

Possible Approach

Find out how long it takes for a gallon of water to flow out of one of the water faucets in the science room. Estimate roughly how high the faucet is above the water main which supplies the building. Then raise the question of how the water is made to flow up into the building. Test a faucet higher in the building and find out whether there is any difference in the rate of flow.

Activities

1. Follow suggestion No. 14 on page 36 of the unitext.
2. Follow suggestion No. 13 on page 36 of the unitext.
3. Follow suggestion No. 12 on page 36 of the unitext.
4. Use a model force pump. Compare the way it works with the way a lift pump works.
5. Examine models of different kinds of faucets.
6. Collect pictures of primitive ways of distributing water.
7. Discuss the means of distributing water shown on the inside covers. On the front inside cover the pictures show: (1) Los Angeles siphon aqueduct, (2) Well with well sweep, (3) Early New York water delivery, (4) Mexican water-carrier, and (5) Cincinnati standpipes. The pictures on the inside back cover show: (1) Near East water wheel, (2) Chinese irrigation device, (3) Ancient Egyptian water-carrier, (4) Water-carrier with goatskin bag, and (5) Roman aqueduct.

Study Problems and Exercises

1. Make a title for the group of pictures on the inside covers. (*P. 25, ¶ 1*)

2. The diagram on page 24 illustrates how one of the following city systems works. Underline the one illustrated.

Portland Springfield Columbus

3. Underline in the list below the city or cities in which you would find pumping stations similar to the one pictured on page 27.

Columbus Springfield Portland

4. Underline the word in parentheses which best completes the sentence.

1) A lift pump has (one, more than one) cylinder valve.
2) A force pump has (one, more than one) cylinder valve.
3) In a lift pump the water goes out of the cylinder when the piston is moved (up, down).
4) In a force pump the water goes out of the cylinder when the piston is moved (up, down).
5) In a lift pump there is (no, one) piston valve.
6) In a force pump there is (no, one) piston valve.
7) If the well is very deep, it is better to use a (lift pump, force pump).
8) In large pumping stations (lift pumps, force pumps, centrifugal pumps) are used.

5. What are the large red towers pictured on the inside front cover? For what are they used? (*P. 27, ¶ 4*)

6. Through what is water distributed inside a city? (*Mains and tunnels*)

7. Name a device which controls the flow of water in the city mains. (*Gate valves*)

8. Name a device which controls the flow of water in our homes. (*Faucets*)

VIII. The Problem of Sewage (pages 29-30)

Core Ideas

One of the very important uses of water is to carry wastes away.

Sewage is likely to contain germs of various diseases, typhoid fever among them.

Sewage should be handled so that it is neither a danger nor a nuisance.

Possible Approach

Call attention to the title of the section. Ask what is meant by the word "sewage." Check by reading the first paragraph of the section.

Activities

1. Examine prepared slides of typhoid bacteria under the microscope.

2. Look up records of typhoid epidemics in your community.

Study Problems and Exercises

1. For what two important reasons do cities need a system of sewers? (*To carry away waste and to carry away storm water.*)

2. Why is the task of preventing storm water from flooding streets and basements a difficult one in New Orleans? (*P. 29, ¶ 3*)

3. Which presents the more serious problem—storm water or sewage? Why? (*P. 29, ¶ 4*)

4. Tell three ways in which people can become infected with water-borne diseases. (*P. 29, ¶ 5, and p. 30, ¶ 1*)

5. Suppose in your community the sewage is being dumped into the only lake in the vicinity. Write a paragraph presenting arguments against the practice. Present the arguments as you might present them to a city official.

IX. Ways of Disposing of Sewage (pages 31-35)

Core Ideas

Sewage disposal systems can handle sewage so that it is not a danger or a nuisance.

The activated sludge system of sewage disposal is a commonly used and satisfactory system.

People on farms and in small towns also must guard against disease by disposing of sewage satisfactorily.

Possible Approach

Call attention to the graph on page 34. Let the class suggest possible reasons for the drop in deaths from typhoid fever in Chicago. Then let them read in the first three paragraphs of the section about a major cause of the drop in death-rate.

Activities

1. Follow suggestion No. 10 on page 36 of the unitext.

2. Follow suggestion No. 11 on page 36 of the unitext.

3. Follow suggestion No. 15 on page 36 of the unitext.
4. Visit a sewage disposal plant.

Study Problems and Exercises

1. Make a title for the two maps on page 30.

2. Why was the course of the Chicago River changed? (*P. 31, ¶ 3*)

3. If Chicago were still dumping all her sewage into the Chicago River, would the health of the people of St. Louis be endangered? Why or why not? (*P. 32, ¶ 1*)

4. Below is a list of the steps Chicago now takes to treat its sewage before it enters the Drainage Canal. These steps are not in the proper order. Number them to show the correct order.

(*9*) The sludge enters a vacuum filter.
(*5*) Compressed air is forced through the sewage to help bacteria in their work.
(*10*) Water enters the Drainage Canal, leaving filter cake behind.
(*1*) The raw sewage passes through screens, which remove large particles.
(*6*) The sewage goes to the final settling tanks.
(*3*) After passing through a meter, activated sludge is added.
(*11*) The filter cake is dried.
(*4*) The sewage enters aeration tanks.
(*2*) The sewage enters preliminary settling tanks.
(*7*) The sludge goes to digestion tanks from the thickening tanks and the first settling tanks.
(*8*) Bacteria act further on the organic material.
(*12*) Filter cake is sold to farmers or burned in incinerators.

5. What was Chicago's typhoid death-rate in 1885? (*See diagram on p. 34.*) What was it in 1900? What brought this sudden change about? (*P. 31, ¶ 1*)

6. What do you suppose has brought the death-rate from typhoid down to an almost negligible figure by 1944? (*The chemical treatment of sewage and the disinfection of the water supply.*)

7. What goes on inside a septic tank such as the one pictured in the diagram on page 35? (*P. 35, ¶ 2*)

Materials and Equipment

(See page 405)

Model lift pump 4
Model force pump 4
Models of faucets 4
Microscope 4
Prepared slides of typhoid bacteria 4
3 ring stands, one tall 4
3 iron rings with clamps 4
Glass funnel 4
2 straight lamp chimneys 4
2-holed rubber stoppers to fit chimneys 4
Glass tubing—3 short tubes and 1 short pipette-shaped tube 4
Rubber tubing 4
Filter paper 4
Tin can
Square of white cloth for covering one end of can
Calcium or magnesium carbonate 3, 4
Soap 2
Bottled spring water 2, 3
Alum 3, 4
Sodium carbonate or borax 2, 3, 4
Salt 2
Sand
Heat

THE WAYS OF THE WEATHER

(Note general information page 5)

I. Introduction (page 3)

Core Ideas

The weather plays a very important part in our lives.

In our part of the world the weather is very changeable.

Possible Approach

Ask the class what kind of weather they are expecting for the day. What reasons have they for expecting this kind of weather? (*Probably some will have heard forecasts over the radio; others will have seen the forecast in the paper.*) Raise the question of whether weather is important enough to be given as much radio time and newspaper space as it is given. Give the class copies of the unitext and let them check their conclusions by reading the first paragraph of page 3. (After this or some similar initial approach, and after the approach to every other division of the unit, normal procedure will include (1) the reading, to solve problems raised by the teacher and the pupils, of any text material not read during the approach, and (2) the carrying on of various other activities such as those suggested.)

Activities (Note: Many teachers will doubtless wish to use Ask the Weatherman in connection with The Ways of the Weather. Duplication of activities in the teaching outlines for these two unitexts has been avoided. Most of the activities suggested for the two would be appropriate for either.)

1. Look for and bring to class cartoons about the weather.

2. Collect written accounts of unusual weather conditions. Mount them so that they can be placed on the bulletin board or in a notebook which can be kept in the science library.

Study Problems and Exercises

1. Make a list of five occupations in which weather plays an important part. Tell briefly what part weather plays in each one. (*P. 3, ¶ 1*)

2. What makes weather reports "news" in our part of the world? (*P.3, ¶2*)

II. WHAT IS WEATHER? (pages 4-5)

Core Ideas

There are seven elements which make up the weather: (1) air pressure, (2) humidity, (3) wind direction, (4) wind velocity, (5) temperature, (6) amount of cloudiness, and (7) kind of precipitation if there is any.

Possible Approach

Ask the class to describe the weather at the moment as accurately as they can. Let them then find, by consulting "What Is Weather?" what elements of the weather they did not mention.

Activities

1. Follow suggestion No. 1 on page 36 of the unitext.
2. Follow suggestion No. 2 on page 36 of the unitext.

Study Problems and Exercises

1. Make a list of the seven elements that go to make up the weather. After each item in your list tell what the third forecast at the top of page 4 predicts about that element of weather.

2. Fill in the blank in this sentence:
"When there is a great deal of water vapor in the air, we say that the ____(*humidity*)____ is high."

III. AIR PRESSURE (pages 5-6)

Core Ideas

Air pressure varies from day to day.

Air pressure is measured with instruments called "barometers."

Rising air pressure usually means fair weather ahead.

Falling air pressure usually means unsettled and cloudy weather.

Possible Approach

Show the class an aneroid barometer (or call their attention to the picture at the top of page 5). Ask what such an instrument measures. Show, by blowing into the opening at the back, that the hand moves with changes of pressure. If an air pump is available, put the barometer on the platform of the pump, cover it with a bell jar, pump a little of the air from the jar, and watch the hand of the barometer move. Call attention to the weather indications around the edge of the dial. These marks seem to show that there is what relation between air pressure and clouds and precipitation? (*The marks seem to show that when the pressure is high, the weather is fair, and when the pressure is low the weather is rainy or stormy.*) Let the class read the last paragraph on page 6 to find whether this conclusion is sound.

Activities

1. In two other unitexts in this series, OUR OCEAN OF AIR and THE AIR ABOUT US, there are directions for performing many experiments that have to do with air pressure. You may be interested in performing some of these experiments.

2. Examine any barometers you can. Notice whether they are marked in inches, centimeters, or millibars.

3. Tell the class of any experiences you have had with unusually low or high air pressure. You may, for example, have tried to cook high in the mountains and had trouble because the pressure was low and water boiled before it got very hot.

Study Problems and Exercises

1. Mark each of the following sentences "True" or "False."

C (1) A barometer measures air pressure.
X (2) We can easily tell by our feelings whether the air pressure is high or low.
X (3) When there is a great deal of water vapor in the air, the air is always much heavier than when it is fairly dry.
C (4) If the air pressure is rising, the weather is likely to be fair.
C (5) If the air pressure is falling, there is likely to be cloudy weather.

2. Examine the chart on page 6.

a) On what kind of instrument was this chart made? (*Recording barometer*)

b) On what day and at what time of day was the air pressure lowest? (*Friday at 2:00 A.M.*)

3. What principle which has to do with the air helps explain why people often plant orchards on hillsides rather than in valleys? (*P. 6, top of page*)

4. A cubic foot of air weighs about 1.2 ounces. About how much does the air in your schoolroom weigh in pounds?

IV. WINDS (pages 7-10)

Core Ideas

Wind is air moving horizontally.

Winds vary greatly in velocity.

Wind is caused by differences in air pressure.

Winds blow from regions of high pressure to regions of low pressure.

The greater the difference in pressure, the greater the velocity of the wind.

Local winds are often caused by differences in air pressure brought about by differences in temperature.

There is a constant procession of highs (swirls of air out from centers of high pressure) and lows (swirls of air into centers of low pressure) across our country.

Highs and lows move in our country from west to east.

The movement of highs and lows brings about many changes in wind direction.

Air moves in toward the center of a low and rises.

Air sinks in the center of a high and moves outward in all directions.

Possible Approach

Ask the class how without any instruments of any kind they could estimate how hard the wind was blowing. Let them check their suggestions by looking at the table on page 7.

Activities

1. Follow suggestion No. 8 on page 36 of the unitext.

2. On transparent paper make a diagram like the one at the top of page 9. Put a dot on a sheet of paper to stand for the place where you live. Move the transparent paper from left to right over the paper on which you put the dot. Move it with the centers of the highs and lows above the dot. Move it with the centers of the highs and lows below the dot. By moving it, study what the changes in wind direction in your locality would be if the highs and lows moved past along various paths.

3. Put three candles close together. Put a large lamp chimney around them. Put little blocks of wood under the base of the lamp chimney so that there will be plenty of room for air to come in there. Hold tiny bits of tissue paper or aluminum foil over the

chimney and let them go. They should be carried upward in a current of warm air. This experiment will help you understand that movements of air may be caused by differences in temperature.

4. Look out of doors. Estimate the speed of the wind by consulting the table on page 7.

5. Try to find newspaper clippings about damage done by winds. (*The recent collapse of the Tacoma bridge, for example*)

Study Problems and Exercises

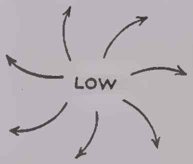
1. Suppose the flag on the flagpole on the top of this building is being blown by the wind so that it stands out straight to the southeast. What can you tell by the flag about wind velocity and wind direction? (*See chart, p. 7*)

2. Mark each of the following sentences "True" or "False."

C (1) Wind is caused by differences in air pressure.
X (2) A wind which has a velocity of 40 miles an hour is a gentle breeze.
C (3) There is a constant procession of highs and lows across our country.
C (4) Highs and lows move across our country from west to east.
C (5) The movement of highs and lows brings about many changes in wind direction.

3. The wind shifted from northeast to north to northwest on a recent day. What would account for this shift in wind direction? (*A low moved eastward with its center to the south.*)

4. What is wrong with this diagram? (*Wind blows toward center of a low.*)



5. Draw a diagram to show that you understand what causes a lake breeze. (*P. 8, ¶ 7*)

6. How do people often misuse the word "cyclone"? (*P. 10, ¶ 1*)

V. TEMPERATURE (pages 11-13)

Core Ideas

Changes in wind direction often bring about sudden changes in temperature.

Clouds and rain bring about changes in temperature.

Temperature is measured with thermometers.

A high often brings cooler weather.

A low often brings warmer weather.

Humidity has a great deal to do with how hot or cold the air feels to us.

Possible Approach

Ask what heats up the earth. (*Sun*) Thinking only of this fact, what day of the year would one expect to be the coldest? (*The shortest, or the one with the sun lowest in the sky*) What day would one expect to be the hottest? (*The longest, or the one with the sun highest in the sky*) Show these two tables, and ask whether they support the answers given.

Highest temperature on December 19, 1937	30°
Highest temperature on December 20, 1937	32°
Highest temperature on December 21, 1937	46°
Highest temperature on December 22, 1937	42°
Highest temperature on December 23, 1937	42°
Highest temperature on December 24, 1937	46°
Highest temperature on December 25, 1937	34°

Highest temperature on June 19, 1936	98°
Highest temperature on June 20, 1936	100°
Highest temperature on June 21, 1936	78°
Highest temperature on June 22, 1936	74°
Highest temperature on June 23, 1936	80°
Highest temperature on June 24, 1936	82°

Lead the class to the conclusion that changes in the height of the sun in the sky and in the length of the day cannot by themselves account for all temperature changes.

Activities

1. For a week guess the temperature each morning on your way to school and then find out from a thermometer how nearly right you were.
2. Find out from the newspapers the highest temperature any city of the country had yesterday. Find out the lowest temperature any city had.
3. Place three thermometers out of doors in three different places. Compare their readings. Try to explain any differences.

Study Problems and Exercises

1. The following table illustrates a statement about temperature made on page 11 of THE WAYS OF THE WEATHER. What is the statement which the table illustrates?

Highest temperature on July 12, 1936, 108°—July 12, 1935, 86°
Highest temperature on July 13, 1936, 108°—July 13, 1935, 88°
Highest temperature on July 14, 1936, 110°—July 14, 1935, 90°
Highest temperature on July 15, 1936, 109°—July 15, 1935, 90°

(*"One day, moreover, is almost never exactly the same temperature as the same day the year before."*)

2. Some years ago Chicago papers reported that within 24 hours one man had been overcome by heat and two others had almost frozen to death. The temperature had been 74° F. at four o'clock one afternoon. By noon the next day the temperature had fallen to 13° F. How would you account for such a change in temperature? (*Shift in wind*)

3. Put a dot in the center of a page to stand for Minneapolis. Draw a high in a position in which it might bring a cold wave to Minneapolis. (*High northwest of Minneapolis, bringing wind from north*)

4. What truth is there in the common saying, "It's not the heat, it's the humidity"? (*P. 12, ¶ 7*)

VI. WATER IN THE AIR (pages 13-16)

Core Ideas

There is always some water vapor in the air.

Water comes into the air by evaporation.

The amount of water vapor in the air varies from time to time.

The amount of water vapor in the air in comparison with the amount the air might contain is spoken of as "relative humidity."

The amount of moisture which the air can hold depends chiefly on the temperature of the air.

If air is cooled sufficiently, some of the water vapor in it will condense.

The temperature to which the air must be cooled before it will lose any of its water vapor is called the "dew point."

Possible Approach

Read with the class the first paragraph of "Water in the Air." Ask the class to suggest a way of showing that there is water vapor in the air of the room. (One possibility: *Fill a tin cup with cold water. Put ice in it and watch for tiny drops of water to appear on the cup. This is the experiment listed below as No. 1 under Activities except that here the temperature at which the water condenses is not taken.)*

Activities

1. Follow suggestion No. 3 on page 36 of the unitext.

2. Plan an experiment to find out what the important factors controlling the rate of evaporation are.

3. Take the temperature of the air with a thermometer. Get some water that is the same temperature as the air in the room. You can mix hot and cold water until the thermometer shows that the water is room temperature. Wrap a piece of cloth around the bulb of the thermometer. Dip it in the water and hold it up in the air. Read the temperature the thermometer now registers. Try to explain it. (*The water is evaporating from the cloth around the bulb and is cooling the cloth and bulb as it does so.*) Repeat the experiment with alcohol, which evaporates faster than water. Repeat it with ether, which evaporates faster than alcohol. Try to see what this experiment has to do with the second sentence of the last paragraph on page 12. (*Perspiration evaporates from our bodies. The faster it evaporates, the more it cools us. If the humidity is high on a hot day, the perspiration cannot evaporate fast and we feel very warm.*)

Study Problems and Exercises

1. What does the following statement mean? The relative humidity at 10:00 P.M. last night was 85 per cent. (*P. 14, ¶ 2*)

2. On which of the two days listed in the table below would you probably feel the heat more? Why? (*P.12, ¶ 7*)

	Temperature	*Relative Humidity*
August 12......................	92°	47%
August 13......................	88°	85%

3. What would it mean to say that the dew point is 57° F.? (*P. 14, ¶6*)

VII. DEW; VIII. FROST (pages 16-18)

Core Ideas

Dew and frost are condensed water vapor.

Dew and frost are formed where you find them; they do not fall.

Frost is not frozen dew. It is frozen water vapor.

Frost and dew are much less likely to form on windy, cloudy nights than on still, clear nights.

Rapid cooling of objects on the earth's surface has a great deal to do with the formation of frost and dew.

Possible Approach

Call the attention of the class to the pictures on pages 15, 16, and 17. Ask from where frost and dew come and why sometimes one forms and sometimes the other. What can the class tell about the weather on the days when the pictures on the three pages were taken? Let them check their conclusions by reading the first paragraph of "Dew" and the third paragraph of "Frost."

Activity

Follow suggestion No. 1 under Activities on page 87 of this manual.

Study Problems and Exercises

1. "The temperature dropped to 52° F. last night, and there was a heavy frost." What is wrong with this statement? (*Freezing point of water is 32° F.*)

2. Why are dew and frost more likely to form on still nights than on windy ones and on clear nights than on cloudy ones? (*P. 16, ¶ 2*)

3. Mark each of the following sentences "True" or False."

X (1) Frost is frozen dew.
X (2) Dew falls.
C (3) We are more likely to have frost if the humidity is 90 than if it is 50.
C (4) We are more likely to have dew if the humidity is 90 than if it is 50.
C (5) Both dew and frost are formed from the water vapor in the air.

IX. CLOUDS AND FOG (pages 18-22)

Core Ideas

Clouds are formed from the water vapor in the air.

There are many different kinds of clouds.

Clouds are formed of droplets of water or of tiny particles of ice.

Fogs are clouds close to the ground.

Fogs vary in density.

Dense fogs may cause many accidents.

Most clouds are formed when moist air is cooled by being forced upward.

Most fogs are formed when moist air comes in contact with cold ground.

Lows often bring cloudy weather because the air moving in from all directions is forced up in the center of a low.

Possible Approach

On the platform of an air pump put a beaker or flask partly full of warm water. Cover it with a bell jar. Let it stand for several minutes so that some of the water will have a chance to evaporate. Then pump air from the bell jar until a fog forms. (*As the air expands when some of it is removed, it is cooled and loses some of its moisture.*) Ask the class to find by reading the second paragraph on page 21 how this experiment helps explain the formation of clouds.

Activity

Follow suggestion No. 4 on page 36 of the unitext.

Study Problems and Exercises

1. Of what are both clouds and fog made? What is the difference between them? (*P. 18, ¶¶ 2 and 4*)

2. What must happen before either clouds or fog will form? (*Air containing water vapor must be cooled so that some of the vapor will condense.*)

3. What is the chief difference between the ways clouds and fogs are formed? (*P. 21, ¶ 3*)

4. List the three chief kinds of clouds and tell how you can recognize each kind. (*P. 19, ¶¶ 3-6; p. 20, ¶ 1*)

5. What would you suggest as a way of decreasing the number of fogs in a city? (*Reducing amount of smoke in the air*)

X. RAIN (pages 22-24)

Core Ideas

The tiny droplets of water which make up many clouds must become much larger before they will fall as rain.

Raindrops large enough to fall are formed above or nearly above the place where they fall.

To account for our heavy rains, air must continue to rise, be cooled, and give up its moisture for some time.

Rainbows are formed by the passing of sunlight through drops of water in the air.

Cloudbursts are merely very heavy rains.

Possible Approach

Ask the members of the group to tell about the heaviest rains they ever experienced. How does one tell how heavy a rain is? How heavy are the heaviest rains on record? Let the class check by reading the last paragraph on page 23 and the first on page 24.

Activities

1. Follow suggestion No. 6 on page 36 of the unitext.
2. The next time it rains, guess how much falls. Then look up the daily weather report and see how nearly right you were.

Study Problems and Exercises

1. Figure how many tons of water fell on one acre in the cloudburst described on page 24 of THE WAYS OF THE WEATHER. (*1815 tons*) There are 43,560 sq. ft. in an acre, and 2,000 lbs. in a ton. A cubic foot of water weighs about 62.5 lbs.
2. It takes an immense amount of energy to lift tons of water into the air. Where does the necessary energy come from? (*Sun*)
3. Why do we not have rain every summer day when there are clouds in the sky? (*First paragraph of section*)
4. How is it possible for rain to fall from a clear sky? (*P. 24, ¶ 4*)

XI. SNOW, HAIL, AND SLEET (pages 25-27)

Core Ideas

Snow, like frost, is frozen water vapor.

Snow is formed rather than rain if the temperature at which the rising air gives up its moisture is below freezing.

Snow makes a protective covering for plants and animals because of the pockets of air between the flakes.

Snowflakes are made up of crystals of ice.

It is never too cold to snow.

Hail and sleet are frozen rain.

Hail may do great damage.

Ice storms caused by the freezing of the rain as it reaches trees, bushes, and other such objects may do great damage.

Possible Approach

Point out that snow, hail, and sleet are all ice and are all forms of precipitation—that is, they all fall from clouds. Let the class try to tell the differences between them and the ways they are formed. Have them check their conclusions by reading the first and second paragraphs on page 25, the fifth and sixth paragraphs on page 26, and the second paragraph on page 27.

Study Problems and Exercises

1. Why is there very little snow when temperatures are very low? (*P. 25, ¶ 3*)

2. Why do we sometimes find grass green when the deep snowdrifts have melted? (*P. 26, ¶ 1*)

3. How do snowflakes differ from hail? (*Snowflakes are frozen water vapor; hail is frozen rain.*)

Activity

Follow suggestion No. 5 on page 36 of the unitext.

XII. Storms (pages 28-34)

Core Ideas

There are many different kinds of storms.

Among the kinds of storms are thunderstorms, hurricanes, tornadoes, and dust storms.

Each kind of storm has definite characteristics of its own.

Possible Approach

Let the class tell of any experiences they have had with severe storms. List the various kinds of storms they report. Then have the class turn through the section quickly to see what other kinds of storms, if any, are discussed in the section.

Activities

1. Collect pictures of storms of different kinds. Bring them to show to the class.

2. Read in *Scribner's Magazine* for March, 1938, "The Barometer Is Falling" by Helen Cowles Harrison. It is the description

of a hurricane—an ordinary one, not one of the very destructive ones.

Study Problems and Exercises

1. List five kinds of storms. After each one tell one kind of damage it is likely to do.

2. Suppose that weather instruments show that the temperature of the air aloft is not very different from the temperature of the air near the surface of the ground. Discuss the likelihood of there being a thunderstorm. *(P. 29, ¶ 1)*

3. Account in two ways for the fact that tornadoes are very destructive. *(P. 30, ¶¶ 3-6)*

4. Why, if you are in the path of a tornado, is it sometimes possible to escape from the tornado? What do you do to escape? *(P. 32, ¶ 1)*

5. Tell two differences between a hurricane and a tornado. *(P. 32, ¶ 4)*

XIII. Weather Lore (pages 34-36)

Core Ideas

There are many common sayings which have to do with forecasting the weather.

Many of these common sayings are unfounded.

Possible Approach

Call the attention of the class to the cartoons on pages 34, 35, and 36. Ask what weather proverbs they illustrate and whether there is any foundation for these proverbs. Have the class check their ideas by reading the third and sixth paragraphs on page 35. Then raise the question of whether all weather proverbs are equally unsound.

Activity

Follow suggestion No. 7 on page 36 of the unitext.

Study Problems and Exercises

1. Quote one weather proverb for which there is no foundation in fact.

2. Quote one weather proverb which has good foundation in fact.

Summary Exercises

1. Match the first and second parts of the following sentences. Copy them.

a) Frost
b) Dew
c) Fog
d) Sleet
e) A cloud

f) is frozen rain.
g) is usually formed when moist air is cooled by expansion.
h) is a cloud close to the ground.
i) is formed at temperatures below freezing when the water vapor of the air condenses on plants and other objects close to the ground.
j) is formed at temperatures above freezing when the water vapor of the air condenses on objects close to the ground.

2. Mark each of the following sentences "True" or "False."

C (1) A low is more likely to bring rain than a high.
C (2) A barometer measures air pressure.
X (3) Air pressure at any one place is always the same.
C (4) Water vapor is dry.
C (5) A fog is a cloud near the ground.
X (6) Snow is frozen rain.
X (7) Clouds are made up of water vapor.
X (8) A rainbow is formed by sunlight shining through water vapor in the air.
X (9) If the barometer is falling rapidly, the day is likely to be fine.
X (10) Air moves out from the center of a low.
X (11) Sometimes the relative humidity in St. Louis is 0—that is, the air contains no water vapor at all.
X (12) The wind in New York is always from the west.
C (13) If air is to lose some of its water vapor, it must be cooled.
C (14) Shifts in wind direction often bring changes in temperature.
C (15) The changing of ice or liquid water to water vapor is called "evaporation."

C (16) The changing of water vapor to ice or liquid water is called "condensation."

C (17) The greater the difference in pressure, the stronger the wind.

X (18) If March comes in like a lion it will go out like a lamb.

X (19) In most clouds the drops of water are very large.

C (20) Lake breezes are caused by difference in temperature between land and water.

Materials and Equipment

(See page 405)

Aneroid barometer 4
Air pump 4
Bell jar 4
Mercury barometer 4
Recording barometer 4
Large lamp chimney 1, 4
3 thermometers 4
Tin cup 1
Beaker or flask 4
Magnifying glass 4
Prism 4
Candles 2, 4
Tissue paper or aluminum foil 4
Alcohol 3, 4
Ether 3, 4
Cotton cloth

FIRMS DEALING IN MATERIALS AND EQUIPMENT

A. I. Root Co., Medina, Ohio. (bees and demonstration beehives)

Carolina Biological Supply Co., Elon College, N. C. (all kinds of biological supplies)

Celestial Map Publishing Co., 244 Adams St., Brooklyn, N.Y. (star maps)

Central Scientific Co., 1700 W. Irving Park Blvd., Chicago, Ill. (general equipment and supplies)

General Biological Supply House, 761-63 E. 59 Place, Chicago, Ill. (all kinds of biological equipment and supplies)

New York Scientific Supply Co., 111-13 E. 22 St., New York City. (general equipment and supplies)

Southwestern Biological Supply Co., 415 N. Tyler Ave., Dallas, Texas. (general equipment and supplies)

Standard Scientific Supply Corp., 34-38 W. 4 St., New York City. (general equipment and supplies)

Ward's Natural Science Establishment, Inc., 302 N. Goodman St., Rochester, N.Y. (minerals, fossils, and biological supplies)

W. M. Welch Manufacturing Co., 1515 Sedgwick St., Chicago, Ill. (general equipment and supplies)

KEY TO MATERIALS AND EQUIPMENT

1. Hardware store
2. Grocery store
3. Drug store
4. Laboratory supply house
5. School supply house
6. Toy store
7. Wood-working shop
8. Book store

(No sources of supply are given for some of the materials in very common use.)

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THE SUN AND ITS FAMILY

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Baker, Robert H. *When the Stars Come Out*. New York: Viking Press, Inc., 1934. Pp. 198. ($2.50)

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McKay, Herbert. *Air, Wind, and Rain*. Book 1 of "In Search of Science." London: Oxford University Press, 1938. Pp. 48. ($0.20)

Jaffe, Bernard. *New World of Chemistry*. New York: Silver, Burdett & Co., 1937, Pp. 566. ($1.80)

FIRE, FRIEND AND FOE

Any high school or college chemistry.

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